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February 25, 1922

ENGINEERING AND MINING JOURNAL

Two Mining Conventions took place in the Pacific Northwest last week, one at Spokane, Wash., the other at Vancouver, B. C. Both are reported in this issue.

A Statistical Record of the operations of the porphyry copper properties in the United States is included in the market section. Excellent results are indicated.

The Diamond Fields of Southwest Africa

By John Wellington Finch

Valuation of Placer Deposits

By Wilbur H. Grant

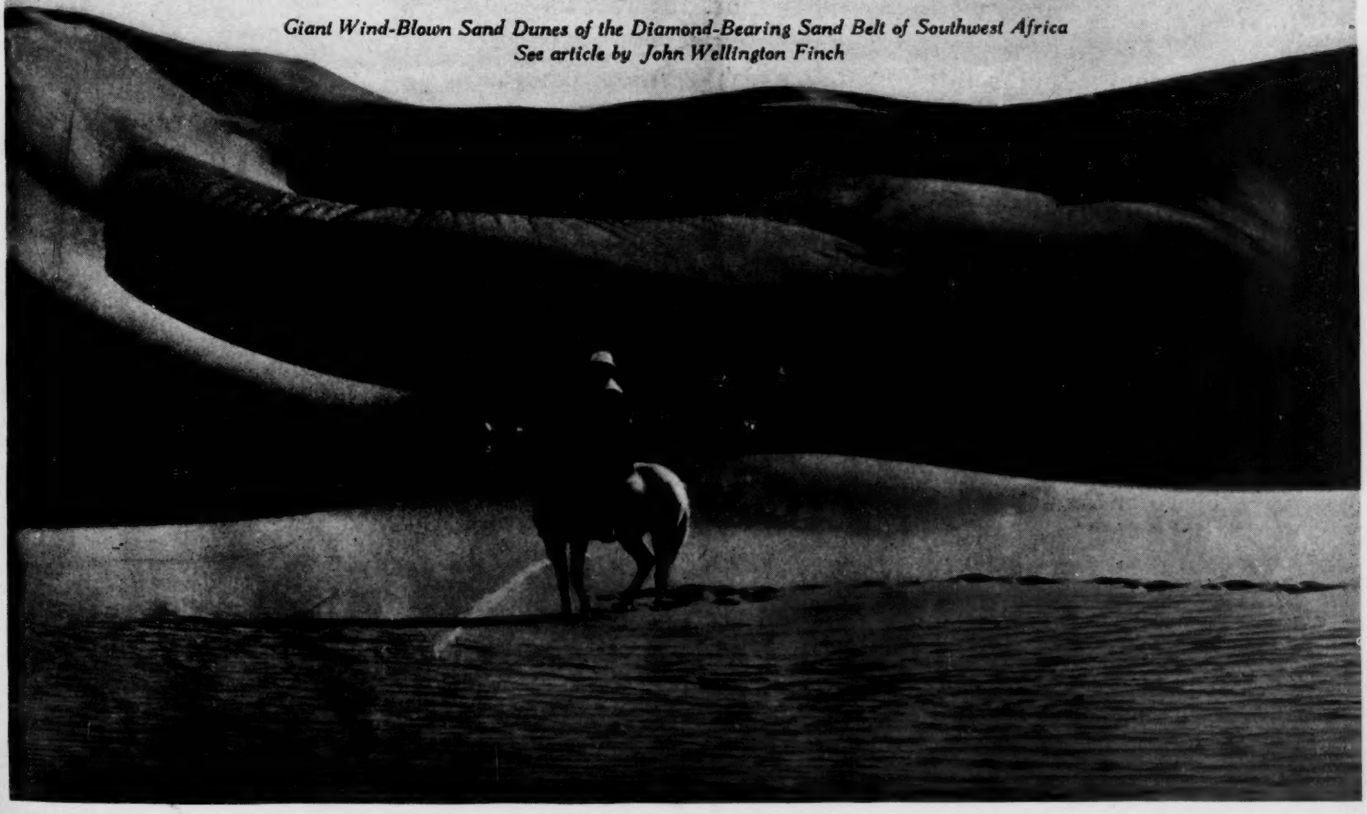
Crushing-Surface Diagrams

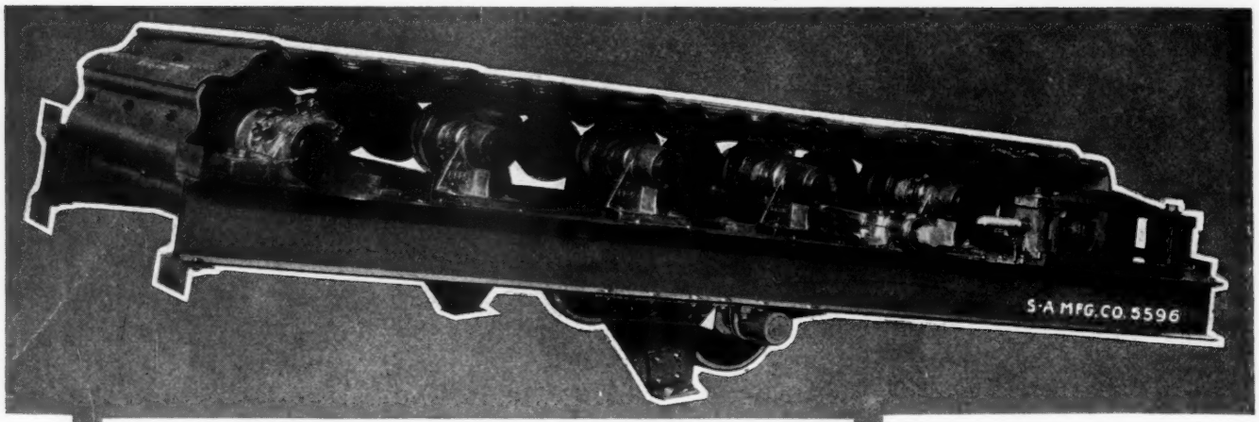
By Arthur O. Gates

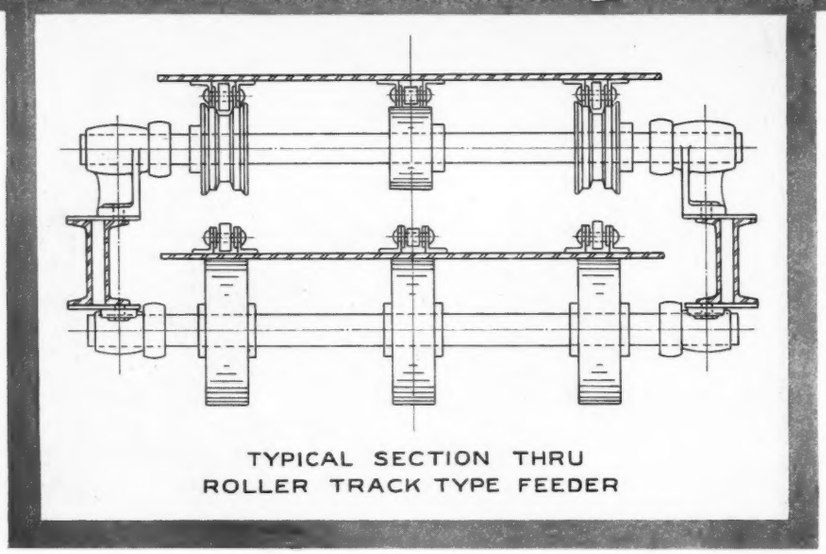
Detonators

By C. S. Hurter

Giant Wind-Blown Sand Dunes of the Diamond-Bearing Sand Belt of Southwest Africa
See article by John Wellington Finch







TYPICAL SECTION THRU
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Engineering and Mining Journal

A Weekly Journal of the Mining and Mineral Industries
METALS NON-METALS PETROLEUM

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Volume 113 New York, February 25, 1922 *Number* 8

Mining and Salesmanship

WE DO NOT FEEL that the copper producers have yet embarked upon an adequate campaign for the cheap delivery of their finished product to the ultimate consumer, or for the popularization of their wares to the small individual buyer, who in the end determines the major market prices for their metal. We believe that we are in a new era, where the consumption and the price of copper will depend on the skill of those interested in merchandising it; and the sooner all frankly realize this situation the better for all. This is a complex age, an age of makeshifts and ingenious substitutes. A saucepan, or a roof, or a screw may be made of a dozen things; and whether it is one or the other which we will buy when we drop into the hardware store depends upon the efforts of the producers in manufacturing, merchandising, and salesmanship.

The aluminum manufacturers studied and perfected their methods first among metal manufacturers. Then came the zinc people, earnestly endeavoring; and the copper producers ponderously brought up the rear. The merger of the Anaconda and American Brass offers great possibilities to the latter, and may blaze the trail for a program for the whole industry. The marketing of molybdenum by the American Metal Company, the owners of the Climax mines, in Colorado, is the best example that we know of the science of merchandising applied to metals and one whose study is recommended.

No doubt this is the indicated line of development for all the mining industries, so that the producer may receive more through the ultimate small consumer paying less. It is the problem of the farmers also; the reduction of the number of middlemen and of their excessive profits, which profits are necessitated by unscientific methods of merchandising. Only the gold producer is free from this necessity of turning merchant, and following his product from the mine to the manufactured small article. He may continue to market his crude product at the established price. This also applies to the domestic producers of silver, as long as the Pittman Act remains effective. But for all the rest, manufacturing, merchandising, and salesmanship are now the big factors in the miner's problem.

The Pyrites Markets

PREVIOUS TO THE WAR, Spanish pyrites was imported in great quantities into the United States. The cheap freight rates made possible by its being brought over as return cargo on ships that otherwise would have returned empty from Europe, joined with the cheapness of production of the great Rio Tinto mines, effectually prevented the development of an important competitive pyrite mining industry in this country. During the war, however, the use of ships for importing pyrites was practically discontinued, owing to the necessity for using the inadequate existing shipping to a maximum efficiency for pressing war purposes; and, coincidentally, the Government encouraged the development of a domestic pyrites industry, which, obedient to these circumstances, sprung up, especially in the middle south Atlantic states, such as Virginia and North Carolina. These incompletely established industries were halted by the Armistice and the consequent cessation of war demand for their product; and the natural remedy that occurred to the pyrite miners was the establishment of a tariff on foreign pyrites.

Meantime, however, the sulphur deposits of the "domes" on the coast of the Gulf of Mexico, in the Texas-Louisiana region, had become developed to such an extent that a superabundance of cheap sulphur became available; and this was put upon the domestic market at such prices that, except in rare instances, pyrites could not compete with it as a source of sulphuric acid. The result was that not only the domestic pyrite industry became dormant, but the dreaded foreign importations also shrunk to a small fraction of their pre-war volume.

In the first ten months of 1921, only 132,754 tons of Spanish pyrites was imported, against 1,093,980 tons in 1916. That the Rio Tinto pyrites will regain its lost market in the United States is extremely doubtful. This could only be attempted by a campaign of lower costs and a sacrifice of profits; and in such a contest it is likely that American sulphur producers could carry the war into the enemy's camp, and compete for the European markets also, against the Spanish pyrites supply. Under these circumstances, a truce, or a division of the world markets, is likely to be maintained.

The Wireless Telephone Now a Practical Instrument

THE USE OF THE WIRELESS telephone has become what almost might be termed common in the vicinity of New York during the last year. The radio aërials may be seen on thousands of housetops in the city and its environs, and so much copper wire has been used in this way that the business of the wire companies is reported to have appreciably improved. The apparatus is freely sold in most of the department stores, demonstrating receiving stations being maintained in each instance, and the New York *Globe* and the New York *World* every day publish columns of information and news. Over 700,000 sets have so far been bought.

Two factors have been responsible for the wide interest in this startling development of science. One is the practice of two or three of the big sending stations around New York of broadcasting news, weather reports, lectures, sermons, and various kinds of music and entertainment. Possessed of a receiving apparatus,

one may recline quietly by the fireside and pick a good time out of the vibrating ether. The second reason for the popularity of radio equipment is its low cost. A simple crystal set may be obtained for as little as $15, and for about $150 one may obtain a truly luxurious outfit with an amplifier so that every one in a room may hear. The De Forest and Westinghouse companies, and possibly some others, are putting out a complete line of amateur equipment. A sending outfit is more expensive, and a license is required to operate it, but still a great many amateurs possess such equipment.

The possibilities of the radio telephone in the mining field are obvious. Even now the prospector in northern Ontario, in his lonely cabin far from human habitation, can sit and listen to (but not see!) the latest Broadway musical comedy sent broadcast at a special performance given for the purpose. Instead of hitching his wagon to a star he has only to hitch his aërial to a tree, or preferably to two trees, and he can hear things passing through the air to which the ordinary mortal is totally oblivious.

The wireless is being used by Government agencies to send agricultural market reports throughout virtually the entire country. Judging by the number of demands for telegraphic and special mail service on *Engineering and Mining Journal* metal-price quotations, it may be advisable to disseminate these by similar means, so that the mining company in the most remote district may be advised of the price he is to receive on the same evening that the information is collected in this office. Important mining news could also be sent by the air route. We shall be glad to hear from those of our readers who have receiving outfits as to what they think of the possibilities.

English, Language and Economics in Mining Schools

A QUESTIONNAIRE of the Mining and Metallurgical Society of America asks the following:

"To what extent and by what methods do you believe English should be taught?

"To what extent and how should foreign languages be taught? Give the languages you suggest in the order of preference.

"How and to what extent should economics be taught?"

A concise, clear use of English is one of the essentials of an engineer, and, for that matter, of every business man. Just to show that the universities are not above the need of this, we quote the following extracts from two different catalogs, letting the chips fly where they will:

"The smelter laboratory is the center of the microscopical activities of the metallurgical research of the United States Bureau of Mines."

"Description of the processes and implements used in the manufacture of copper, lead, zinc, tin, minor metals and of the precious metals. Study of the chemical and physical principles involved. Properties, further treatment and application of the extracted metals and some of their alloys."

Certainly there is need of precision in the use of words and language. We do not believe that a dab of English given in a one-hour course will reform a group of mining students. What is wanted is a conscientious instructor of English who will collaborate with the technical instructors.

The beginnings of language instruction should be started in the high school. Students of marked ability should be encouraged in the university to continue their language studies until they have a good reading knowledge of some foreign language. A man's horizon is distinctly broadened by knowledge of languages other than his own. Either French or German, or both, should be studied; Spanish has a utilitarian value to some mining engineers, and those students who intend to operate in Spanish-speaking countries should be advised to take this subject.

For an engineer, economics is essential. The groundwork of the principles of economics should be taught and then followed by the economics peculiar to the mining industry, together with a thorough review of metal and mineral marketing.

The World's Water Power

WITH THE INCREASED APPLICATION of electricity (especially with the perfection of long-distance transmission), the possession of water power becomes more and more a prime factor in determining the wealth and prosperity of an otherwise vigorous people. Water power may, in a large measure, take the place of the fuel minerals, coal and oil; or it may conserve those even where they are produced in relative abundance, and divide work with them for greater average efficiency.

The Geological Survey recently estimated that the United States possesses 40 per cent of the developed water power of the world, water wheels having a capacity of 9,243,000 horsepower having been installed. Canada comes second among nations, with 2,418,000 horsepower, or over 10 per cent of the world's total. New York State leads the states, with 1,300,000 horsepower, and California is next with 1,111,000.

Compare these figures with the developed horsepower in some of the most advanced European countries: France has the largest developed power in Europe, but, with 1,400,000 horsepower, hardly more than that of New York State. The Scandinavian peninsula is rich in water power: Sweden has 1,200,000 horsepower, and Norway 1,350,000. Little Switzerland, with her Alpine rivers, has 1,070,000 horsepower.

Niagara Falls has the largest water-power development in the world. Increases in capacity now being made will bring the total to 1,284,500.

These figures are for developed power. How about ultimate possibilities? The total potential water power of the world is estimated at 439,000,000 horsepower. In these potentialities, Africa leads by far all the continents, according to the estimate, with 190,000,000 horsepower; and this fact may at some distant day determine Africa as a great industrial continent. Asia, for all her vast area, has only 71,000,000 horsepower, while Europe has 45,000,000. North America has the considerable figure of 62,000,000, of which 28,000,000 only are in the United States. South America has 54,000,000 horsepower.

When we consider the various sources of power, especially coal and water power, we are safe in assuming that for many centuries North America will continue an industrial area of the highest degree of importance.

Without hydro-electric power, many of our mines could not be operated at all: and more and more will electricity form part of the chief problems of every important mining operation. Besides the power function, it is altogether likely that the time will come when electric smelting will solve the problem of many of our refractory, because perplexingly and intimately mixed, ores.

On the Ground Floor

EVERY DAY INVESTMENTS are being made more attractive. The prize one, where you get the most for the least money, is one offered in a circular over the letterhead of the First State Bank of Burnet, Texas, and coming from the office of W. C. Galloway, cashier. The picture of Mr. Galloway's Fort Worth office—a twelve-story building—adorns the letterhead.

This circular invites you to be a stockholder in a "Syndicate," or "Ground Floor Crowd." What the assets, holdings, or development plans of this "Ground Floor Crowd" may be, is not revealed. It really doesn't matter; the inference, let drop incidentally, that this is or is to be an "oil company" is quite sufficient. You are invited to be a stockholder in this "Ground Floor Crowd"; more than that, the circular, printed and with a printed signature, invites you to be a Director! "On account of your familiarity with different oil companies, and on account of the treatment which you have received at the hand of the different oil companies" (Oh, bitter recollection!) "your experience and judgment should be of material benefit to the success of the company, and I want you to accept a place as one of its Directors." This to "Dear Friend," printed.

It is understood that "Dear Friend" might not be able to attend all the Directors' meetings, "but some of the other Directors also live out of Fort Worth," and you "could write your opinion and view by mail." There is here evinced a magnificent disregard of the law that "Directors cannot delegate their authority nor appear by proxy at meetings, but must be personally present in order to act thereat." (Conyngton on "Corporate Management.")

How much must you invest to become a Director? One hundred dollars if you have it. "Any one of your earning capacity and ability is amply able to invest $100, and you should do it, thereby availing yourself of the opportunity to its fullest extent." If, however, you are not prepared to go the limit, "if you cannot invest that much, you may send your check or note for a smaller amount." What we should like to know is whether we can be a Director for as little as fifty cents. And in this connection, we note that the Texas law (Overland, "Classified Corporation Laws"), prescribes that Directors shall not be more than thirteen in number. A maximum of thirteen hundred dollars may therefore be raised (within the law).

While no assets of lands or oil are dangled before the eyes of the hundred-dollar Directors, a more sensible and productive scheme is unfolded—in fact, these suckers are promised that they shall feed on other suckers.

"As one of the organizers, $100.00 gets for you 1,000 shares, whereas after the company is organized, it will take $1,000.00 to get 1,000 shares. This will get you a quick profit of ten for one. After the company is organized, and the advertising campaign started, a contract is to be made with two brokers; one to organize a sales force to sell stock to raise money with which to drill a well; the other to organize a sales force to sell the stock belonging to the organizers or ground floor men, and his efforts, together with the efforts of the organizers or ground floor men themselves, should in a short time enable each ground floor man to get his money back. Then if you wanted to sell more stock and make $7.00 or $8.00 on each $1.00 invested, you could do so, or if you wanted to ride the balance through until the well was completed, if it should be a gusher, it would make you an independent fortune."

Who would take a chance on striking oil when he can make 700 to 800 per cent by such a quick and safe turnover? The other road to fortune is long, involved and tortuous—after (1) the company is organized and (2) the advertising campaign started, (3) a contract is to be made with a broker, (4) to organize a sales force, (5) to sell stock to raise money, (6) to drill a well. Then (7) if it should be a gusher! Ah, if!

Says Galloway, "I want to treat you in a fair and honorable way. I do not want you nor any one else to be able to say that Galloway snatched this opportunity away from you while you were hesitating and undecided."

Does Galloway get the prize?

E. & M. J. Index

THE INDEX for Vol. 112 of the *Engineering and Mining Journal* is now ready for distribution and will be mailed only to those who request it. Those who wish a copy of the Index are requested to send for it promptly. A postcard will do.

WHAT OTHERS THINK

Drilling Results and Dredging Returns

In the various articles relating to the discussion and comparison of the estimated value of dredging ground by the examining engineer and the actual recovery by dredging, the burden of proof seems to have been placed upon the engineer. Though there is a consensus of opinion that the types of drills used are not mechanically perfect and that the human equation is a variable, the same stress has not been laid upon the dredge and its operators.

It is admitted that the modern dredge and its equipment are efficient and that the percentage of loss is small after the material is once on board. However, a slight negligence on the part of the winchman will set at naught the gold-saving devices of the dredge.

In lode mining, it is easily ascertainable if all the estimated tonnage has been extracted, and by assaying the tailings it is possible to calculate the percentage of error, but in dredging it is not the practice to resample the area after dredging to ascertain if all the estimated values have been extracted. Tailings from the dredges are sampled, but this will show only the percentage of loss of the amount placed on board.

The prospecting of dredging ground is usually under the direct supervision of the engineer in charge, and every effort is made to secure as accurate results as possible with the given tools. The methods used vary in detail but not in principle.

In drilling, when the hole reaches bedrock it is continued into it, and, if possible, a core is pulled, so that there cannot be a loss of gold due to failure of the pump. Will the winchman display the same amount of diligence and patience if he encounters a reef which is particularly troublesome? It is, of course, within the province of the engineer to estimate how much bedrock must be dug to recover the estimated values and whether this be economically possible.

At an Alaskan property, drilling showed that good values extended into the crevices of the shattered limestone for 6 ft. Subsequent shafts showed that it would

be unprofitable to remove the bedrock for a depth greater than 2½ ft. Therefore, gold recovered by drilling below this depth was disregarded, and values were estimated from surface to 2½ ft. in bedrock. The estimated value was 61c. per cu.yd. and the recovery 61.8c. The gravels were lifted by hydraulic elevators and sluiced and the bedrock was observed.

A 6-ft. vein of hard quartz crossed the pit and formed a riffle, behind which there was a heavy concentration of gold. The point is that the estimated value and the recovered value closely checked, but, had the ground been dredged, the heavy concentration in the vicinity of the quartz vein would not have been recovered, and it is improbable that a dredge would be capable of digging to an equal depth.

The foregoing illustration is comparable to lode mining, where all operations can be observed. If, however, the same ground had been dredged, it is probable that the recovery would have been much below the estimate.

Character of bedrock greatly influences recovery, more particularly with respect to small dredges than on the larger types, which have the strength and power to move hard material.

In the various examples cited in the articles published, the estimated values are stated and also the actual recovery by subsequent dredging. However, the expected percentage of recovery and the loss in tailings are not stated, so that a fair comparison of estimated value against recovery cannot be made. It is usual to estimate a certain percentage of testing results as recoverable, this percentage being dependent on the character of gravel, especially with regard to clay content, the character of the gold, whether coarse or fine, the character of the bedrock, and the experience of the engineer.

The generally accepted practice of drilling one hole per acre does not seem to me to be sufficient for an accurate estimate, except in operations where the test values are greatly in excess of maximum operating cost.

In the example above cited, the bedrock consisted of a series of shales and limestones, with a dip of 15 to 20 deg. The shales could have been easily dug, and a high recovery by dredging was possible. The limestone was shattered and full of crevices, making the digging hard and a high recovery impossible. The alternate beds of shales and limestones were thin, so that, had the deposit not been drilled at 100-ft. intervals, it would not have been possible to estimate the percentage of favorable and unfavorable bedrock upon which to base an estimate of the percentage recovery, and as the values were consistently higher in the limestone area than in the shale area, it would not have been possible to give the drill-hole values the proper weights.

I believe that the lack of sufficient development is owing to the fact that in earlier development the nature of gravel deposits was not fully understood and that the gold was believed to be distributed more evenly than has been found to be the condition in practice. It is certain that, as the industry has developed, the testing of the gravels has become more rigid. Nevertheless, the amount expended for the development does not approach the sums expended for this work in other branches of metal mining. The money spent for development in lode mining before the installation of reduction equipment is from three to five times that spent on examination and development of dredging properties, figured on the basis of dollars developed per dollars expended, which is probably due to failure to note that usually the examination and development of a dredging property are carried on simultaneously and the cost of examination seems excessive, whereas, as, a matter of fact, part of this cost should be considered as a development charge.

The usual procedure in lode mining is to make a preliminary examination of the prospect. If satisfactory, a development campaign is started, and when it is sufficiently advanced, a thorough examination is made, the orebodies are sampled, the tonnage is calculated, and estimates are made for the proper size of plant to extract the metals economically. The engineer examining a lode mine has an advantage over the one examining a dredging property, in that he can more closely observe the working conditions and make allowances more accurately for losses or barren zones and the character of the wall rock, which may be soft and cause dilution of values. However, admitting the imperfection of drilling methods, like imperfections of method occur in lode sampling, with perhaps a lesser percentage of error. I believe that with the same proportionate amount expended upon development of a dredging property as on a lode property a comparable degree of accuracy would be obtained.

New York. EUGENE H. DAWSON.

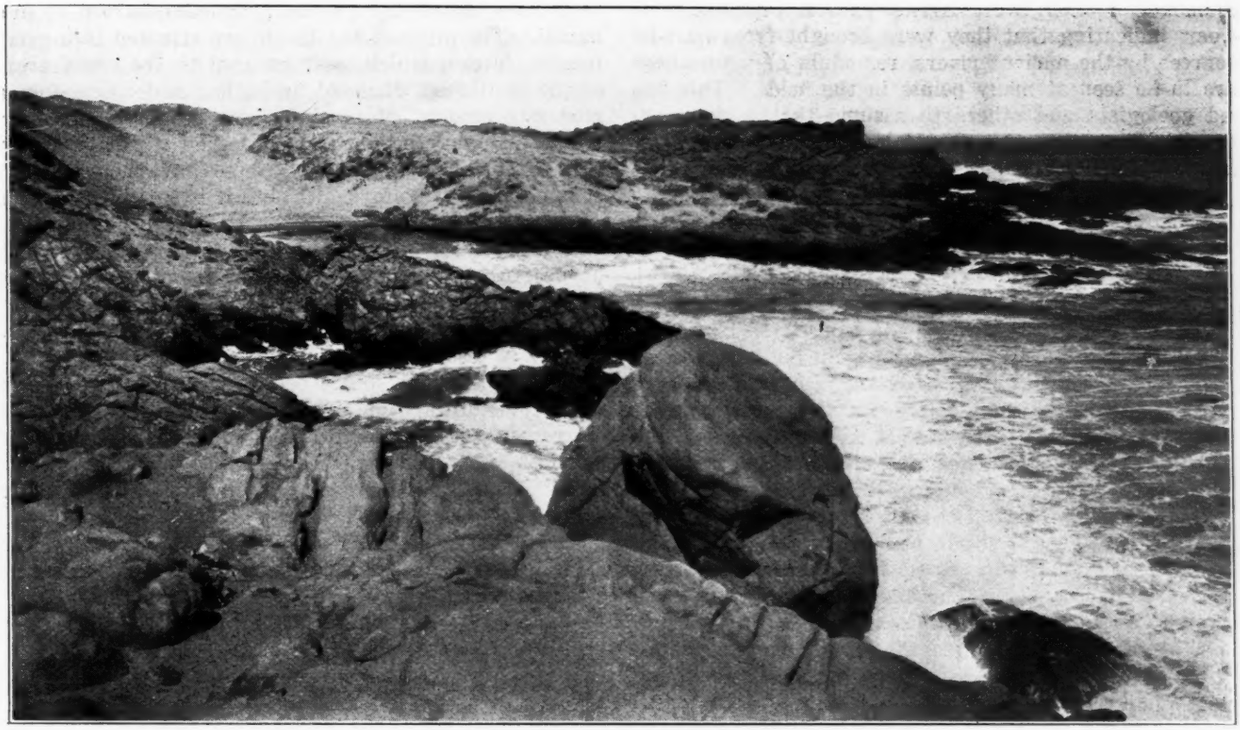
Engineering Education

In *Engineering and Mining Journal* of Feb. 11 is a letter by T. T. Read in which he records some observations on engineering education. If I understand his remarks correctly, he would have many of the applicants seeking entrance to engineering colleges turned away and sent to vocational schools, because "we need more foremen and assistant superintendents and fewer educated engineers of the type of Rossiter Raymond and Pope Yeatman," to quote him approximately.

This is a startling suggestion. Many teachers of engineering students, including myself, have been laboring under the belief that the world needs, not so much foremen and petty bosses, as broad-minded, cultured engineers like Herbert Hoover, to take a younger man as an example. Every week or so we hear of Hoover being suggested to direct this or that difficult job. Apparently engineers of his wide knowledge and social insight are much in demand. If there were more Hoovers in power at Washington and more of them in important positions in industry throughout the country, the benefit would be enormous. I think the country could use several thousands of Hoovers at least, to replace that number of lawyers, bureaucrats, and rubber-stamps now in office. Should not, then, the engineering colleges seek to develop as many broad-minded, cultured engineers as possible instead of the somewhat narrow, unimaginative type of engineer that Philip Cabot condemned in a recent address?

There is, of course, the difficulty that independent, imaginative individuals like Hoover are frowned upon and discouraged immediately upon leaving college, because they have a mind of their own and do not defer to the assistant superintendent. Hoover, himself, spent his formative years abroad, finding more encouragement for his ability in Australia, China, and London than in the United States. This, however, is a fault of the American employer, not of the American engineer; and if more engineers of broad vision and imagination were being produced, the industrial system might learn to absorb them in place of the inferior types now favored.

New York. P. B. MCDONALD.



THE POMONA COAST OF SOUTHWEST AFRICA

The Diamond Fields of Southwest Africa

Wind Action and Ancient Rivers Responsible for Presence of Precious Stones in Loose Sand and Gravels on Face of Desert — Agreement of Producers Controls Diamond Output of Southwest Africa and Protectorate — Mining and Milling Practice Simple

BY JOHN WELLINGTON FINCH
Written for *Engineering and Mining Journal*

THE TERRITORY owned or held under lease by the Consolidated Diamond Mines of Southwest Africa, Ltd., and by its subsidiary, the South West Finance Corporation, Ltd., is shown on the accompanying map. The properties cover a great part of the known payable diamondiferous land of the Protectorate, formerly German Southwest Africa. Diamondiferous gravels are found in an area extending ninety miles along the seacoast, but the important deposits lie in a strip beginning east of Luderitzbucht, in the Kolmanskop diamond company area, and extending sixty miles south. The maximum distance of diamond deposits from the coast is nine miles. This area yielded 606,423 carats in 1920, 90 per cent of which was produced by the Consolidated Diamond Mines company.

The following table gives the particulars of output and diamond sales under the German regime:

	Diamonds Received, Carats	No. of Diamonds, per Carat	Diamonds Sold, Carats	Value
1909-10.....	560,977	5	560,977	£836,000
1910-11.....	798,865½	5¾	798,865½	1,069,000
1911-12.....	816,296	6½	816,296	1,045,000
1912-13.....	902,157	6.09	902,157	1,324,500
1913-14.....	1,570,000	4.97	1,284,727	2,698,500

Stock carried forward, 285,273 carats.

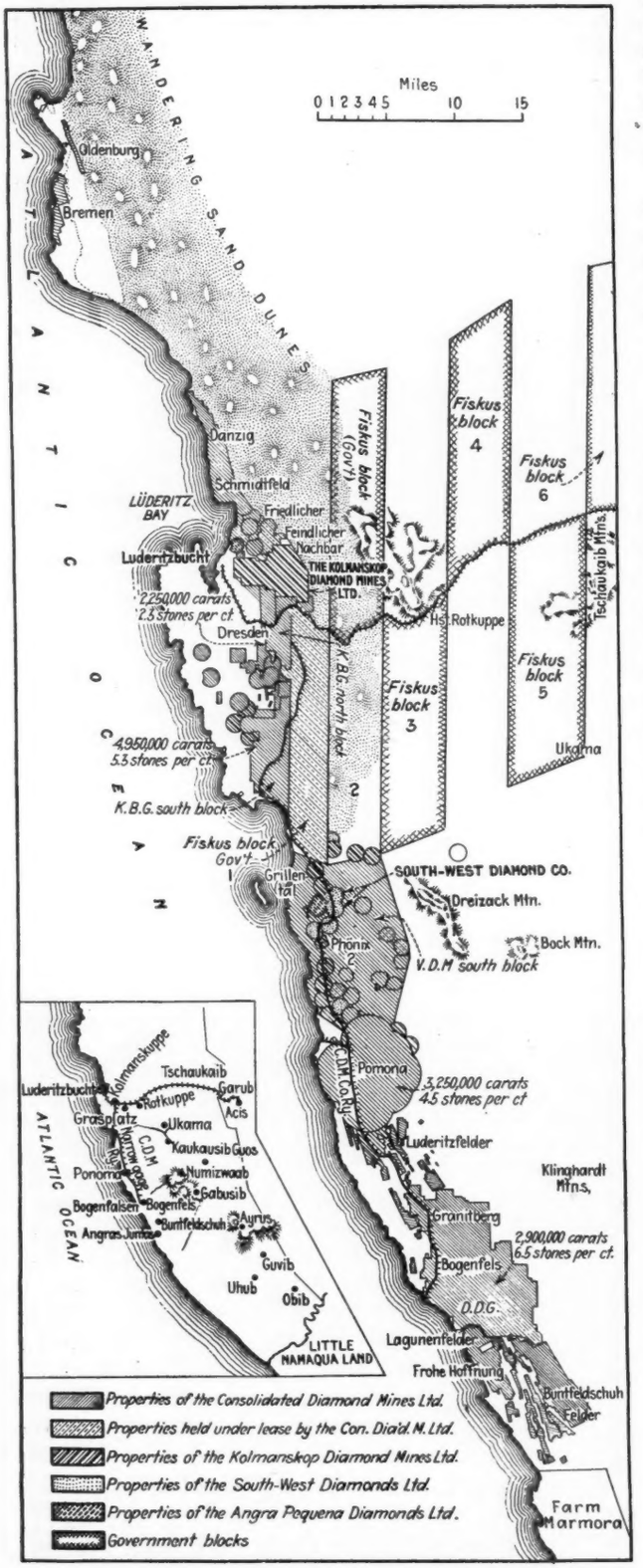
Aside from the more than ample living quarters for white employees and excellent offices at Luderitzbucht and Kolmanskuppe station, the principal equipment of the company is the power plant at Luderitzbucht, a large milling plant at Kolmanskuppe, and smaller mills on the principal properties formerly owned by the German-controlled companies; also a narrow-gage railway serving the mining areas. The power plant, operated by a separate company, though not modern, is well constructed and reasonably efficient, and is capable of supplying more power than the field will ever require, not only for the Consolidated company but for any outside demands. Natal coal is used for producing gas.

Power sales in 1920 were: 679,016 kw-hr., Consolidated Diamond Mines Co.; 349,076 kw.-hr., Kolmanskop Diamond Mines, Ltd., and 94,400 kw.-hr., used by the town of Luderitzbucht and also by other minor consumers.

The power plant is equipped as follows: Two gas-engine units of 1,000 hp. each; two gas-engine units of 600 hp. each, and one gas-engine unit of 155 hp. All units are direct coupled to three-phase, alternating-current electric generators producing current at 3,000 v. There is also the requisite direct-current unit for excitation. The current is stepped up to 30,000 v. as transmitted to the mines and railway. A 208-v. current is delivered to consumers in Luderitzbucht. All transformers and transmission lines belong to the operating company.

The diamonds are found in loose sand and gravels on the face of the desert, left there by wind and water. The "river diamonds" of the Union show much wear by attrition, because they have been transported by streams considerable distances from their places of origin. The

diamonds of Southwest Africa exhibit practically no wear, indicating that they were brought from near-by sources by the ancient rivers, remnants of whose beds are to be seen at many points in the fields. This has led geologists and others to assume that a diamond-bearing kimberlite pipe should be found somewhere inland and near at hand. Pipes have been found, but tests have shown them to be practically barren of diamonds. The pipes of the Union are situated in a great inland plateau, which, as compared to the coast areas of the Southwest diamond fields, has undergone only a moderate amount of erosion since the pipes were intruded. Doubtless thousands of feet of the original vertical extent of the Protectorate pipes have been removed. It is possible, therefore, although it is entirely theoretical, that the Protectorate pipes have been cut down to such a depth that the more highly diamondiferous parts have been removed, and that discovery of payable pipes is not now to be expected. Nor, on the whole, are they wanted. The company has abundant diamond deposits in a more desirable form.



MAP OF SOUTHWEST AFRICAN DIAMOND AREA

There is some reason to believe that the diamonds of the Protectorate came from a single pipe. Over the entire field they are uniform in quality, appearance, and habit of crystallization, whereas no two of the productive South African pipes yield diamonds identical in quality or appearance.

Pomona Conglomerates Show Diamond Concentrations

The two principal oldest river channels crossed the region just south of the Pomona area and into the Fiskus No. 1 and K. B. G. blocks. From the latter, diamonds have been redistributed by two transverse second-period river channels, one of which entered Elizabeth Bay in the South Block K. B. G. In the latter region a later river of a third period, redistributing diamondiferous gravels of the two former periods, entered the sea at approximately the same point. The rich conglomerates within the Pomona area are, in my opinion, a concentration of diamonds by an old river of the first period combined with wave action along an ancient shore line. The topography of the Pomona area is somewhat rugged, and this first-period river channel has been removed at inland points. The former rivers were probably intermittent flood rivers, as are those today, and materials brought toward the coast by them were reworked by the winds concurrently, as now.

Wind Action Important in Diamond Distribution

That the present wide distribution of the diamonds has been accomplished by wind transportation is unquestionable. The diamonds of the Pomona and D. D. G. areas gradually decrease in size northward from the old river deposits in that region; then again about the mouths of the river channels of the several periods in the Elizabeth Bay region coarse diamonds are found, thence gradually decreasing in size northward to the limits of the field. In the latter region it is clear that the winds have moved and redeposited the diamonds and other associated materials for a distance of fifty kilometers, or over thirty miles, and fine sands several times further. This is not at all astonishing to one who visits the fields and watches the wind in operation. Its most important economic effect has been a concentration of diamonds which is largely responsible for the payability of the fields. As the sands and gravels advance northward, barren fine sands are removed and carried beyond into the great group of dunes shown in the northern area on the map herewith. These are of such size as to resemble a mountain range, and this vast bulk of worthless material has been removed by nature from the diamond deposits.

Along the coast the Southwest Protectorate is an absolute desert of the most forbidding type; inland it is semi-desert and most unpromising for the development of agriculture or any other considerable source of public revenue. Before the war, when it was a German province, it was looked upon by the imperial government as an entering wedge to political expansion toward the Province of German East Africa. Its value was more strategic than actual. It was not self-supporting, and its commercial future depended fundamentally upon the development of mineral resources. Aside from copper deposits which were discovered in the northern part of

WELL OF BRACKISH WATER, SOUTHERNMOST DIAMOND FIELDS

the province and have since been profitably worked, the diamond fields, on which mining was started in 1909, gave the greatest promise of an economic future for the region. The German imperial government, having ambitious plans for the province, as soon as the diamond fields were brought to a considerable stage of production, naturally exacted taxes to the utmost limit, and several of the original companies were unable to make satisfactory profits at the prices then prevailing for diamonds.

After the province had been handed over by mandate to the Union of South Africa, all the rules and regulations which had become established under the German regime were respected and perpetuated. All properties are subject to a tax of 66 per cent of the gross proceeds of diamond sales, less 70 per cent of the cost of production. There is usually also 1s. 6d. per hectare land or claim tax and a Regie[1] tax of 2 per cent of gross proceeds, both allowed as working costs. A sixpence per carat is added arbitrarily to the working costs in the principal areas of the company's properties. Ten per cent interest on the unredeemed value of plant and buildings and 10 per cent depreciation on equipment and all things used in producing diamonds are also allowed as costs.

Amortization Considered as Working Costs in Taxes

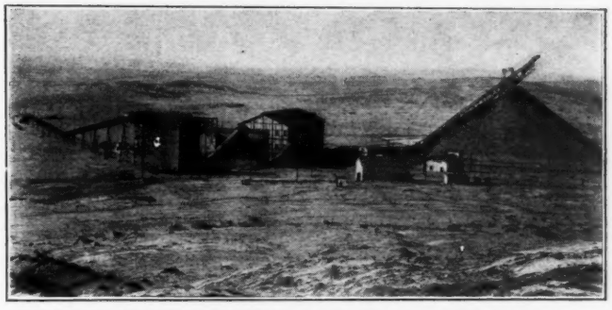
As compared with the diamond mines of the Union provinces, taxes in the Protectorate are higher, though a greater allowance is made in working costs. Amortization is regarded as a part of working costs, whereas in the Transvaal amortization is deducted from the gross profit, and the balance is called net profit, which is shared between the government and the mining company.

Government administration in the Protectorate is carried on in behalf of the Union government by an administrator appointed by the premier. Under him are local commissioners at the principal towns. The administrator has broad authority.

Government for Benefit of Community

I was considerably impressed with what appeared to me to be the spirit of the government of the Union of South Africa. Although in the recent election the radical labor party was defeated, the government nevertheless remains mildly socialistic, and governs its people and their business in a paternalistic manner. It appeared to me that a corporation in the Union of South Africa is not primarily regarded by the government as a source of profit to its shareholders, but as an organization existing for the benefit of the community. This is well illustrated by the increase of rates of the government railways in the Transvaal and Natal. In the effort to realize for the government by freight rates all that the traffic would bear, the coal-mining companies and practically all other industries particularly dependent upon railway transport are having a hard struggle for existence. The territory covered by the provinces of the Union is so poorly developed that the sources of revenue by taxation are few, and just at this time the government is far from self-supporting. Its revenues were principally from mining. The gold production is now greatly decreased because of the closing of many of the exhausted older mines and of others on account of high working costs. The revenues of the Union from the diamond industry have suddenly become practically nil. The government is so badly in need of funds that it is not to be expected that relief from taxes, or from other concessions which might contribute to greater profit to corporations, will be easily secured.

Though some of the foregoing statements may appear pessimistic, there is another point of view which is



THE KOLMANSKUPPE MILLING PLANT

hopeful. General Smuts, the premier of the Union government, is one of the world's greatest personalities; progressive, sound and far-seeing. Unless his conspicuous ability leads to his being drawn permanently into the councils of the Empire in England (which is unlikely, on account of his great devotion to South Africa), an effort to give just and intelligent administration of public affairs will be made while he is at the head of the government. Corporations can count upon fair and reasonable consideration of grievances which are of sufficient importance to command the premier's personal attention.

[1]The Regie was at first an organization established by the imperial German government to take charge of the sale of diamonds. It consisted of eighteen associated firms organized into a corporation, three of which represented producers, the others being banks in Germany. Later on, after much controversy, the producers secured a 50 per cent representation, the government took over 30 per cent, and representatitves of the diamond-cutting industry 20 per cent.

In the 1915 and 1916 period of the war, Protectorate diamonds were offered by the Union government of South Africa in large quantity. This threatened to undermine the control of the London Diamond Syndicate. The Syndicate and the De Beers company came to an agreement to tender for these diamonds on joint account in January, 1916. The De Beers company also acquired control of the Premier mine, and in Otcober, 1916, the Syndicate came to a further agreement to purchase the Premier output. Afterward an understanding was reached with the government, so that since February, 1917, the diamonds of the three great South African producers and those of the Protectorate have been sold through the one channel under fixed quotas. It has long been recognized, both by the government and the Union producers, that control of output is necessary.

The sales of the diamonds of the Protectorate are made through the administrator to the Syndicate. In a conference held in Pretoria on Dec. 31, 1919, it was agreed to limit for a period of five years the quantity of diamonds put upon the market to an amount salable to the Diamond Syndicate for £3,000,000 per quarter, the quota allotted to each of the companies being as follows:

	Per Cent in Value
De Beers Consolidated Mines, Ltd.	51
South West Africa Protectorate	21
Premier (Transvaal) Diamond Mining Co., Ltd.	18
New Jagersfontein Mining & Exploration Co., Ltd.	10

The quota of 21 per cent allotted at this time to the administrator included not only the Consolidated Diamond Mines company but all other producers in the Protectorate. An agreement has since been made whereby a special sales permit of £200,000 per annum is allowed to the other producers, leaving to the Consolidated Diamond Mines company the full quota of 21 per cent.

High Diamond Prices Forced Reduced Demand

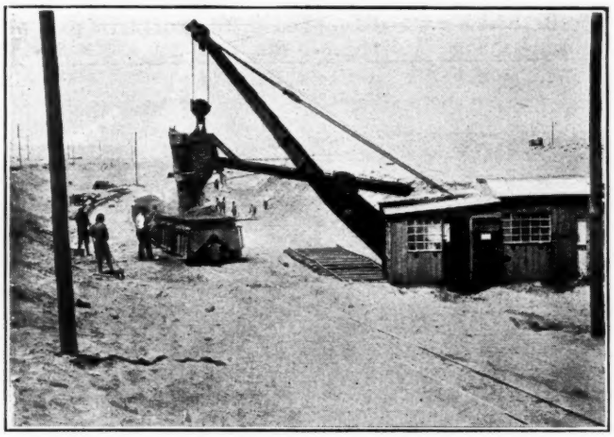
The Syndicate, taking advantage of the period of abnormal demand for diamonds, had restricted sales, and prices had risen to an unprecedentedly high level, 170s.

HAND SCREENING AND SORTING, KOLMANSKOP DIAMOND MINES CO.

for Consolidated diamonds. War profiteers were apparently the principal purchasers. This period was followed by an abrupt reaction. The retail dealers found that there was no class of people in America or Europe willing to make large purchases of diamonds at such high prices. The trade has, however, passed through similar periods of depression in the past—for instance, in 1907—and no doubt is entertained as to the resumption of business when the world's purchasing power recovers.

In 1919 diamonds were produced in other countries as follows: Belgian Congo, 275,000 carats (now at the rate of about 250,000); Borneo, 5,000 carats (no probable increase); British Guinea, 20,000 carats (no probable increase); Brazil, 150,000 carats (large percentage industrial diamonds), a total of 450,000 carats, which is equal to 17½ per cent of world's output.

The important African diamond mines, excepting those of the Protectorate and the Congo, produce from kimberlite volcanic pipes by underground mining methods. Outside the Syndicate group, a source of



ELECTRIC SHOVEL AT KOLMANSKUPPE

small production is from the gravels of the river valleys draining the areas containing the pipes of Kimberley, Premier, and Jagersfontein. These diamonds appear to aggregate usually about 5 per cent of the carat production of South Africa, but digging was stimulated by recent high prices. The production has now become small again. It is not a stable business, being mostly done by a vagabond class of miners, always hoping to strike it rich, but seldom doing so.

River diamonds average larger in size and better in quality than diamonds from the deep mines, and therefore represent considerably more than 5 per cent of the sales price of South African diamonds. In 1919, river stones sold at an average price of 261s. 6d. per carat, the diamonds from the kimberlite mines at 87s. 3d. per carat, and those from the Consolidated Diamond Mines at 112s.

The outside producers in the Protectorate have averaged from 2 per cent to 3 per cent of the total South African production.

South Africa furnishes normally about 85 per cent of the world's diamonds, 92 per cent of this coming from the mines of the Syndicate group, which, therefore, are to be credited with 78.2 per cent of the world's production. Hence the Consolidated Diamond Mines company supplies 16.4 per cent of the world's production.

America is the chief purchaser of diamonds, and is looked upon as the principal probable market for many years to come. For the last few years the sales to America have been as follows, including diamonds cut, uncut, and industrial:

1916	$36,382,321	1919	$85,523,086
1917	32,606,254	1920	47,221,511
1918	21,085,733		

Of these imports the diamond-cutting center at Amsterdam contributed 81 per cent in 1917, 80 per cent in 1918, and 83 per cent in 1919. These have represented practically the sales from the mines through the London Diamond Syndicate to the United States.

It is possible, of course, that new payable kimberlite pipes will be found. Many pipes have been discovered, but those containing diamonds in commercial quantities have been the exception. Moreover, the areas of the Union and Rhodesia have been thoroughly explored for them. There are unexplored areas in the jungle of the Belgian Congo which may contain pipes, but exploration will proceed slowly. The present producing deposits of the Congo are alluvial, which are very likely capable of increased production.

There are three active mining companies in the Southwest diamond fields besides the Consolidated company. Of these the Kolmanskop Diamond Mines, Ltd., probably has a reserve in unmined areas of 500,000 carats, and is making an average production of about 3,000 carats per month, selling at 75s. 8d. per carat, on account of small size. The other companies, in July, August, and September, 1920, produced at the rate of 870 carats per month.

So far as communication by sea is concerned, the diamond properties are favorably situated. Lüderitz Bay is a satisfactory harbor. The coast at other points, however, is rocky and offers no suitable landing places. The territory of the mines must, therefore, be served by railway.

MINING AND MILLING OF SIMPLEST CHARACTER

Except for minor adverse effects from desert conditions, a simpler operation of mining from the engineering point of view is hardly conceivable. The prevailing process is of the easiest type, the removal of loose or only moderately consolidated material from the surface of the earth; and the milling also requires the separation of only a single mineral, which lends itself to satisfactory concentration. But many refinements of method effecting profits will be developed as the work proceeds.

In general, the deposits consist of sand and gravel in varying relative proportions, a minor amount of which is semi-cemented in strata, as is usual in deserts. Such strata are generally specially rich in diamonds. On account of the presence of materials of this class, crushing is necessary in milling. Most of the materials mined are now screened by hand in the field to eliminate fine sand said to contain no diamonds of value. Coarse boulders are also picked out, and the remaining gravel is sent to the mills. Power shovels will do away with much of the present expensive hand work in the field, and it is likely that it will be found advantageous to treat in the mill practically all material mined.

New Caledonia Nickel Industry Barely Alive

The present condition of the nickel industry in New Caledonia is described in a recent number of the *Board of Trade Journal*, an abstract of the original article appearing in the *Journal of the Society of Chemical Industry*. The British consul at Nouméa reports that as there is no market for nickel most of the nickel mines in New Caledonia have been closed down or their production has been reduced. The Société le Nickel, of Paris, and the Société des Hauts Fourneaux de Nouméa are still working their mines, and a little work is being done at the Maconnaise and Gracieuse mines at Dumbéa, near Nouméa. The two first-named companies own large areas of undeveloped mining land and also nickel-smelting works. A large hydro-electric plant with a capacity of 30,000 hp. is being erected at Yate for the Société le Nickel and a nickel-smelting plant, erected at Nouméa by a Japanese company, has not yet begun operations.

Exports of ore and matte from New Caledonia have been as follows:

	Metric Tons	
	Ore	Matte
1913	93,194	5,893
1914	94,154	5,287
1915	48,576	5,529
1916	30,679	4,935
1917	32,018	6,319
1918	15,612	3,938
1919	1,561	3,813
1920	3,246	4,508

The reduced export of ore is due to the development of local smelting plants, which will soon absorb the whole production. In recent years France has taken practically all the ore and the United States most of the matte.

Bureau of Mines Studying Purification Of Copper-Sulphate Solutions

At the Pacific Experiment Station of the U. S. Bureau of Mines, at Berkeley, Cal., the purification of copper-sulphate solutions resulting from the leaching of low-grade oxidized copper ores is being studied. The technical and economic solution of this problem would make possible the obtaining of high-grade copper by electrolysis instead of the low-grade copper product which must be smelted and refined.

The experimental work done has been chiefly on the precipitation of ferrous and ferric iron from copper-sulphate solutions by the use of limestone. Results show that the ferric iron could be almost completely removed without precipitating copper, and possibly the ferrous iron could be made to precipitate also. Further work on a larger scale is necessary to determine whether the process is commercially feasible.

Production of Lime Decreased in 1921

About 2,531,000 short tons of lime, valued at $24,536,000, was sold in the United States, including Hawaii and Porto Rico, in 1921, according to an estimate made by the U. S. Geological Survey, from reports made by the principal producers. This quantity is less than that sold in any year since the Survey has collected its statistics and is 29 per cent less than that sold in 1920. The average value per ton in 1921 is estimated at $9.69. In 1920 it was $10.52, and in 1919 it was $8.84. Of the forty-two states and territories that produced lime in 1921, five increased and twenty-seven decreased their output as compared with 1920. The five states that increased their outputs in 1921 made only small gains and were affected by local or special conditions, such as contracts made late in 1920.

The sales of hydrated lime in the United States in 1921 were estimated at 737,000 short tons, a decrease of less than 14 per cent as compared with those in 1920, whereas the sales of quicklime (including refractory lime or dead-burned dolomite) were estimated at 34 per cent less than in 1920. Of the thirty states that reported an output of hydrated lime in 1921, only seven showed an increase in production. The estimated value of the hydrated lime sold in 1921 was $7,673,000, an average value per ton of $10.41. The average value per ton in 1920 was $10.89.

Detonators

Compounds of Fulminate and Chlorate Used To Increase Efficiency—Methods of Testing—Factors Affecting Completeness of Explosion—Composition Detonators

By Charles S. Hurter
Written for *Engineering and Mining Journal*.

In practice the detonation of high explosives is accomplished by means of an intermediate agent that will produce a violent impulse embodying both shock and heat. According to some investigators, the ideal condition would be to have a detonator of a special composition for each kind of explosive, as within certain limits some seem to be more sensitive to the heat factor and others to the sharpness of the shock. This, however, is not commercially practicable, and the aim of the manufacturers has been to make an all-round satisfactory detonator.

Until recently fulminate of mercury has formed the basis of nearly all commercial detonators, and at present, in most of them, this compound is the main ingredient. Mixtures of fulminate of mercury with other compounds are made with the object of increasing its sensitiveness to ignition and also for increasing the volume and temperature of the gaseous products, to give a greater effectiveness; detonating in its own volume, as it does, the effect of straight fulminate is too local. The compound most commonly used for the purpose noted is chlorate of potash.

Compounds of Fulminate and Chlorate

The chemical reaction involving fulminate of mercury and chlorate of potash for complete combustion of their products may be expressed according to the following equation:

$$3\,Hg\,C_2N_2O_2 + 2K\,ClO_3 = 6\,CO_2 + 6N + 3\,Hg + 2\,KCl$$

Molecular weights are 852.12 for the fulminate and 245.2 for the chlorate. At the detonation temperatures of fulminate of mercury the oxides of mercury cannot exist.

According to this reaction 852.12 parts of fulminate of mercury are mixed with 245.2 parts by weight of chlorate of potash to bring about complete combustion. This proportion can be expressed approximately as 78 per cent of fulminate and 22 per cent of chlorate. The mixtures used in detonators have varied from 95 per cent fulminate of mercury and 5 per cent chlorate of potash to 80 per cent fulminate and 20 per cent chlorate.

According to tests made by the Bureau of Mines (Technical Paper No. 125, "The Sand Test for Determining the Strength of Detonators") several years ago, the 80—20 mixture creates a more effective detonating impulse than the 90—10, the 95—5 mixture, or even straight fulminate.

Testing Detonators

In regard to testing detonators, it must be remembered that their efficiency is their ability to detonate high explosives. Consequently, the only true and reliable tests of detonators is to use them for this purpose and observe the results. As a general rule, blasting-cap manufacturers make up a special insensitive explosive for this purpose. There are a number of other tests that can be made which tell more of the condition of the detonator involved rather than afford an accurate comparison between different kinds or makes. As a matter of fact, the detonators can be varied in shape and make-up so as to improve the results obtained in these various tests without increasing their efficiency when it comes to detonating high explosives, and in some instances the modifications may even reduce their ability to produce the most perfect detonation.

The Lead-Plate Test

One of the simplest is the lead-plate test. This consists of cutting a 1½ in. square from 10-lb. sheet lead (about $\frac{5}{32}$ in. thick) and centering this on the end of a short piece of 1¼-in. iron pipe in a special holder. This holder permits the placing of a blasting cap so that the end is held firmly and squarely on the lead plate. Two results are noted after the explosion of a detonator, one of penetration and one of radiating lines on the plate called "sunburst effect." This test is an indication of the comparative condition of a single kind or make of detonators.

Any method of concentrating the charge will increase the penetration effect. An increase in diameter of the copper shell, which concentrates the charge close to the plate, results in a much better penetration effect, but, as will be shown later, this same concentration, if carried to extremes, lowers the efficiency of a blasting cap when it is used to detonate high explosives.

The reduction of chlorate of potash in the detonator charge results in a more concentrated load, due to the high specific gravity of fulminate of mercury, with resulting better plate tests despite the fact that the 80—20 mixture is considered to be more efficient in the detonation of high explosives than the 90—10, the 95—5, or straight fulminate. Another point is that a cap having an indented end gives a better plate test than one with a flat end, and, further, this test will show poor penetration with a cap whose end bulges out in a convex form. On the other hand, when tested with explosives, the shape of the capsule end is shown to have no effect on the results.

The Sand Test

The simple test of the Bureau of Mines consists of (Technical Paper No. 125, "The Sand Test for Determining the Strength of Detonators") measuring the shattering effect of detonators in quartz sand. One hundred grams of sand screened through a 20-mesh and caught on a 40-mesh sieve are placed in a special container. The test consists of exploding the detonator in the center of this mass and then determining the shattering effect on the sand. In this test a long detonator with a smaller diameter will give a better test than the concentrated charge of one having a large diameter, on account of a greater amount of sand in close proximity to the explosive charge.

Another test is that of the Trauzl block. A hole is bored partly through a lead block of given weight.

The diameter of this hole is just large enough to admit a blasting cap. Then after exploding the cap the volume of the resulting cavity in the lead block is measured, the size being indicative of the strength of the detonator tested. Still another is to explode a cap on a plunger in a special apparatus, under certain standard conditions. This plunger acts on a thin sheet of copper, and the capacity of the resulting "dish" is taken as indicative of the strength of the detonator.

Completeness of Explosion Depends on Amount of Explosive Set Off at Start

The completeness of the explosion and the distance it travels through the charge depends on the amount of explosive actually set off at the start by the detonator. This is governed by two facts, the size of the detonator charge and its distribution. The first is self-explanatory. By using a small-diameter detonator which extends the charge, the amount of explosive acted upon by the detonator is increased and the consequent detonation wave started off with greater intensity. Another point is that no explosive attains its maximum rate of detonation or violence instantly in the first layers affected.

Even fulminate of mercury does not start its detonation at full speed. This, however, is attained quickly after the detonation is started. Consequently, in the smaller-diameter detonators, a larger percentage of the fulminate charge is exerting its maximum possible effect, owing to its being extended over a greater length, which gives it a chance to attain its maximum violence of detonation, which is not the condition with the larger-diameter blasting cap containing the same charge.

It is true that fulminate of mercury attains its full velocity more quickly in a large-diameter capsule, but with an explosive so sensitive this point is negligible when compared with the better results obtained from the explosive detonated by having a larger amount of this explosive brought under the direct influence of the fulminate. Also, it is possible with fulminate of mercury, as with all the other high explosives, to reduce the diameter of the charge to a point where the detonation wave cannot pass through it. The necessary diameter for good fuse limits the manufacturer to a minimum inside diameter of 0.221 in. for blasting caps. The making and placing of a substantial plug in electric blasting caps necessitates a minimum inside diameter at 0.260 in.

Effectiveness of Composition Detonators

The subject of the effectiveness of composition detonators, referred to in some of the Bureau of Mines reports as reinforced detonators, is therefore of pertinent interest. It has been shown beyond question by the Bureau of Mines and other investigators that certain nitro-substitution compounds and nitrated carbohydrates, such as nitrovene, tetryl, tetranitroanilin, and nitromannite, each with a small quantity of fulminate-chlorate mixture as a primer, make, if anything, more efficient detonators than fulminate and chlorate alone. The compounds named must be kept in close confinement if they are to exert their full explosive force, and to obtain this the small amount of fulminate used as a primer is placed in an interior copper capsule which is seated firmly on the charge. In fact, good confinement is necessary for detonator charges as well as for all other explosives.

Some blasting caps that have appeared on the market will not detonate unless rightly crimped on the fuse. Even the straight fulminate-chlorate caps give a better test and improved detonation results when they are tightly fastened on the fuse than when only partly crimped or held loosely in place. The lighter specific gravity of these compounds results in a more bulky and extended charge in the shell, with a greater amount of explosive upon which a direct action is exerted as a result. Thus the detonation wave in the main explosive charge is started off with a greater intensity and a better explosive action, and more satisfactory results are obtained. This type of detonator is being received with favor, and with later perfections that will probably be evolved may largely if not completely replace the present-day fulminate-chlorate blasting caps.

The subject of the care of blasting caps and precautions to be taken in using them is so well covered in the explosives companies' catalogs and other literature that I have not considered it necessary to repeat them in this article.

Mining in Arkansas in 1921

By Tom Shiras

Written for *Engineering and Mining Journal*

Mining in Arkansas was hit hard in 1921, the production being less than in any other year in the last decade. The price of zinc ore was so low as to prohibit operations, and not a mill in the north Arkansas field turned a wheel. Two carloads of hand-cobbed silicate, produced by the Odum mine, in the Zinc camp, was the only production reported. There was more ore developed in the ground at the mines when the price broke than at any other time in the history of the field. This ore will not be mined, however, at a price less than $35 a ton, the minimum at which a reasonable profit can be made. There was no prospecting or new development work in progress during 1921.

In the Batesville manganese field, in Independence County, some work was done during the year, but 2,000 tons will easily cover the tonnage shipped. A number of operators expect to conduct operations in 1922, however. In a recent interview with Colonel Allan, of Chicago, consulting engineer for the American Manganese Co., a Chicago concern, which during the last few years has acquired a considerable acreage and some of the best properties in the field, he states that uniformity in both production and grade would alleviate a great many of the troubles of the operators in the field. In making contracts with furnaces the operators should be able to furnish a certain tonnage and a certain quality. If shipments are irregular and there is a constant change in the quality of the ore the operator is soon put out of the market. These objections can be easily overcome by employing a chemist and by properly sorting and grading the ore before any attempt is made to treat or market it.

Interest centered in oil in Arkansas during 1921. The Eldorado field came in January, 1921, and the state went wild. Wildcatting all over the state became a popular investment with those who take long shots. There was hardly a county in the state that could not show a project of this nature, after the middle of the year. None of these wildcat projects has brought in another field. However, the final result of these tests cannot be determined yet, because many of them have not been completed.

Crushing-Surface Diagrams and Rittinger's Law

Discussion of Various Experimental Work Which Tends To Disprove The Theories of Kick and Stadler — A Thorough Understanding of Fundamental Laws Held an Aid to Economical Crushing and Grinding

BY ARTHUR O. GATES
Written for *Engineering and Mining Journal*

I OFFERED some thoughts on crushing a few years ago, and took part in some discussions which at times perhaps became rather exciting and acrimonious even if they were not interesting. Perhaps my coinage of expressions like "mesh-tons" and "crushing-surface" were accountable. But mesh-tons appears to have stuck, for a number of writers use this and similar expressions in referring to the work done in crushing; and others are using the Crushing-Surface diagram in analyzing milling operations.

Some will recall a little controversy over the laws of crushing: the power proportional to volume reduction theory of Kick and advocated by Stadler, and the power proportional to surface produced, called the law of Rittinger, in Richards' "Ore Dressing." The war raged pretty strong in South Africa, where it was the subject of presidential addresses, and in Australia. The South Africans, backed by the British, were in support of Kick, and the Australians seemed more interested in Rittinger. And then, of course, Americans had to butt into it. And it was largely a fight of theory, supported by experiments made about the time Noah was a pup, and quotations from the ancients.

RE-ESTABLISHING RITTINGER'S LAW

I certainly would not have broken into the controversy had I not taken an inventive streak and found that the Rittinger law could be made use of in such a simple manner and graphically to show so many things which take place in crushing. When one adds a long column of figures and the result comes out in round numbers, it is well to go back over them and find out where the mistake occurs; it always is there. And so in the midst of a great work in determining all (I hoped) the resistances to crushing of all the rocks, came rumors of somebody in South Africa or elsewhere who had upset Rittinger's law—and all my work was gone to smash. And so it was necessary to look into the laws of crushing and get to the bottom of them. The bottom was not reached, but enough data had been obtained experimentally to give assurance that the Crushing-Surface diagram was on a fairly sound basis.

Certain of the theoretical proof which was offered for Rittinger's law in my original paper, "The Crushing-Surface Diagram," published in *Engineering and Mining Journal*, May 24, 1913, was criticised as based upon a confusion of work and force. I admit it—the original draft of the paper had the error there—but before it was submitted it was discovered, and for several days the bubble was burst, the boom had gone flat, and all the beautiful theory and that diagram were useless, and my time had been wasted.

Whether Rittinger confused the two, work and force, is not to be determined from Richards' "Ore Dressing," but I saved the Crushing-Surface diagram by making a statement that the distance through which adjacent particles must slip to make a break is the same regardless of the size of the rock of which they are constituents. One can see this when one thinks in terms of molecules, but when one thinks of the big pieces of rock in testing machines, and stress-strain curves, and elastic limits, the point is missed that it is breaks that are being considered. And then there was balm for the soul in an extract from an old *American Machinist* which J. D. Hoffman had put into his notes on Machine Design, to the effect that in punching steel plates the depth of penetrability varied not directly with the thickness of the plate, but that the punch had to go almost the same amount in each case before the punching freed itself; it was not a clean proof, but it was evidence, and there were experimental data.

EXPERIMENTAL PROOF OFFERED BY BELL

With all this controversy on the laws of crushing, I was the only one to offer experimental proof, until the work of Prof. B. W. Bell and his associates at McGill was published in 1916 or 1917.[1] This proof was more or less negative, however, because in the use of the Rittinger law there is all that surface between 200 mesh and 100,000,000 mesh (which is somewhere near the molecule) unmeasured, whereas Stadler, with his energy units and ordinal numbers, had only those between about 17 and 56 (corresponding to 100,000,000 mesh) to worry about. (These are based on Taggart's scheme for the use of Tyler standard screens; Stadler's would have been about 26 and 90). And he had an increasing quantity of power applied per energy unit as he went from fine to coarse; it should have been the same. My data were not as entirely convincing as to the correctness of Rittinger's law as they were to the error of Kick's. But the results at McGill left no room for doubt; the check on the error of Kick was complete, and there was a much better proof of the correctness of the Rittinger law. The McGill tests must have taken fully one hundred times the expense and effort that was attached to mine.

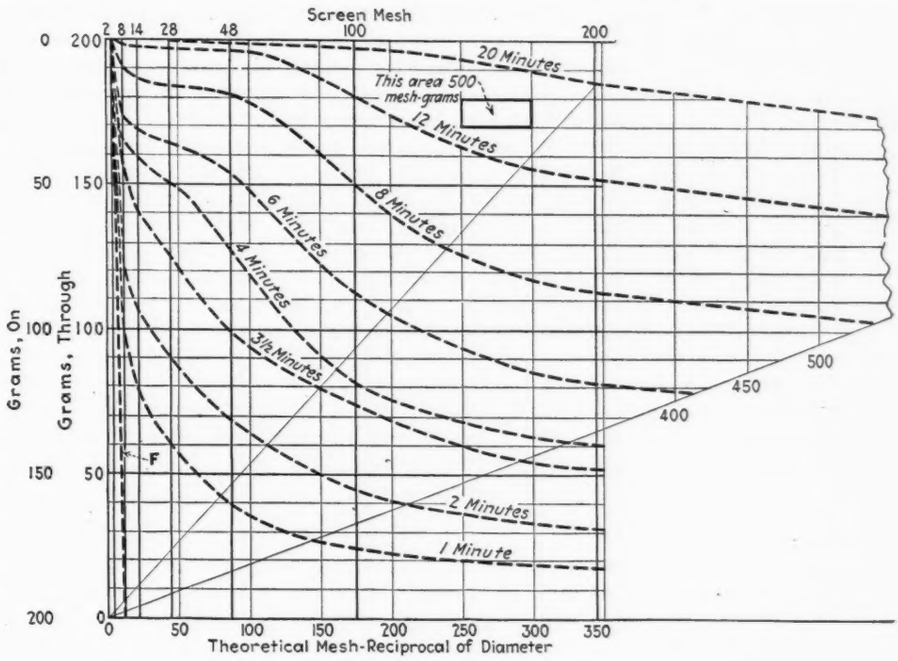
At one period I had corresponded with Dr. Porter, of McGill, with regard to his methods in the use of the testing machine, and had begged him, with tears in my Corona, to take back some statements of a preliminary nature which had come out from McGill to the effect that Kick's law was apparently correct. There was some rejoicing in the winter of 1917 when the prodigal returned to the fold.

COLLEGES NEGLECTING THEIR OPPORTUNITIES

What irritates me in this whole controversy on the laws of crushing is the attitude of the majority of our mining-college faculties toward the subject. They seem dead on their feet, content to take a neutral attitude, explain both laws, say east is west, or north or south,

[1] "An Investigation of Rock Crushing Made at McGill University,"; John W. Bell, *Trans.* Canadian Mining Institute, Vol. 19; and *Trans.* A.I.M.E., 1917.

and "let them row it out." The thing is so easy to prove. Luther Lennox showed one way different from mine, or from the McGill way, in which he runs a ball mill with a known charge of ore and known weight of balls for definite times, and in which time is the only power variable, and therefore is a relative measure of the work.[2] All that is needed is a small ball mill. Into it place about 200 grams of ore, run it for one minute, screen size and return for another minute, screen size and return for another minute, and so on until too fine for further grinding. Plot all on one Crushing-Surface diagram, figure up Stadler's energy units, as well as mesh-grams, and then plot both; estimate average size against time, and see if the thing is not conclusive. Every student could make a test of this kind and get it out in two periods, and then he would know. Only it should be tried by the "Prof." first.



CRUSHING-SURFACE DIAGRAMS
Time a variable.

Approximately 50 per cent of the cost of milling is charged against crushing. Can we know too much about it? Not only do the college professors seem content to let the matter of the laws of crushing settle themselves, but writers of textbooks (I refer particularly to the handy and valuable "Handbook of Ore Dressing" by A. W. Allen) prefer to straddle the subject, rather than make any decisions based upon the evidence presented. I do not see where the milling operators get anything from such neutral attitudes, for one certainly goes to textbooks for decisions rather than for indecisions.

Allen records both supposed laws, with examples for their application, and in the middle states that "Rittinger's law was disproved by Van Reytt as the result of actual demonstration. The tests showed that the ratio of actual work done to increased surface is fairly constant with coarse sizes, but with fine sizes the increase of surface is much more rapid than the work required to produce it." I have attempted at various times to study the Van Reytt tests as given in Richards' "Ore Dressing," and the best that I can make out of them is that the conclusions which Allen and Richards quote are based upon *feed* conditions rather than *product* conditions. I make out that Van Reytt intended to convey the impression that if the feed is coarse the surface in the resulting product is proportional to the power expended upon its production, but if the feed is fine it does not take nearly so much power to produce the same amount of surface.

Van Reytt and McGill Results Do Not Check

This does not check with other test data available, particularly the McGill tests, which were more elaborately done than Van Reytt's. The McGill experimenters' work showed that the more efficient of their tests with rolls gave practically the same amount of surface per effective horsepower with feeds of the following diameters in inches: 0.50, 0.29, 0.18, and 0.11. With the same rolls crushing a feed of 0.07 in., the surface produced is recorded as about 20 per cent less per effective horsepower than for the coarser sizes; Van Reytt had it just the opposite.

Professor Bell, of McGill, goes into the subject of the relation of the power applied to rolls to the tonnage, and it probably could be discovered in Van Reytt's experiments, if all the data were available, that practically all the power used on the roll tests was friction load, additional power being consumed with the larger pieces owing to greater friction in the bearings of the rolls caused by the excessive bearing pressures.

In my Purdue tests it was likewise shown[3] that it takes apparently more energy to produce a unit of fine surface than one of coarse, and it is explained that the minus-200 mesh is largely responsible for the surface unaccounted for.

Luther Lennox, in his article "The Crushing Resistance of Various Ores,"[4] makes use of the Crushing-Surface diagram, and that full credit for energy spent in fine crushing be given, carries his calculations for surface out in the minus-200 mesh sizes, and gets fairly good checks on surface produced per unit of crushing energy when he carries his curves of sized products out to 1,670 and to 2,500 theoretical mesh (reciprocal of diameter). Crushed products of two degrees of fineness are compared upon this basis.

Van Reytt's experiments and conclusions should be considered upon their merits, along with those of the others who have published results of experimental tests which apply to the distribution of work in crushing.

There are plenty of evidences in mill operations, especially in view of the fact that the types of crushing machines used have friction elements which are not influenced by crushing pressures as in rolls, that energy proportional to the mesh produced is essential for a given tonnage of ore.

[2] *Bull.* A.I.M.E., August, 1918.

[3] "Kick vs. Rittinger," *Trans.* A.I.M.E., Vol. 52, p. 875 et seq.

[4] *Bull.* A.I.M.E., August, 1918.

The results of recent tests are reproduced here which have some interesting points and which may be used as one of the additional bits of evidence against the volume reduction theory of Kick and Stadler. The tests were made somewhat as suggested by Luther Lennox in the paper already mentioned. A definite charge of ore (in this instance 200 grams) was placed in an 8-in. ball mill and crushed by rotation of the mill. The numbers on the lines designate the number of minutes the test was run. In each test the 200 grams of feed minus-2 mesh and plus-8 mesh was run for the time specified, but, for purposes of checking, the products which had been run two minutes and four minutes were each run an additional four minutes, giving a total of six and eight minutes' run, which were averaged with the previous runs of those times.

In this work only one element of the energy applied was variable: time. It follows readily that energy applied to the work of crushing varies as the time.

It was not difficult for me to tell almost at a glance that these data were unfavorable to the so-called Kick's law, and so calculations were made just to determine the production of the so-called energy units, using the ordinal numbers for Tyler standard screens as proposed by Taggart,[5] with the exception that 20 is used for the minus-200 mesh, which is probably a little fairer than the 18 or 19 they seem to allow. The following table practically tells the whole story.

TABLE I—RELATIVE ENERGY UNITS PER UNIT WEIGHT

Minutes	Total	Total Less Feed	Per Minute, Total Period	Per Minute, Last Period
0 (Feed)	900	.....	....	....
1	1,847	947	947	947
2	2,092	1,192	596	245
3½	2,548	1,648	495	340
4	2,753	1,853	463	308
6	3,009	2,109	351	128
8	3,472	2,572	321	231
12	3,742	2,841	237	67½
20	3,930	3,030	152	26½

Perhaps it is not fair to take into account the twenty-minute run in which nearly everything was "slimed," but if Kick's law were correct, all the figures in the last two columns should be approximately the same! So much for Kick; there are so many interesting things in this diagram that he can be dropped at this point.

Certain probable laws of crushing in mixed masses may be gathered from this diagram or in connection with it:

(a)—Each piece of rock broken by a single blow becomes a number of pieces varying in size between about half the original size and an extremely fine size which may be considered to have been produced by the rubbing together of the fracture faces. It is probable that the result of plotting the screen analysis of such a break would appear on the Crushing-Surface diagram as a hyperbola. The abrupt change in character of the curve of feed (*F* on diagram) after one minute in the mill, and the considerable amount of minus-200 mesh shown, indicates Curve 1 to be the summation of a lot of these hyperbolas.

(b)—In crushing mixed feeds, the character of the screen analysis of the product follows that of the feed. Note how the changes in the curves follow one another.

(c)—In any crushing operation on mixed feeds, the fines surrounding a coarse particle will be more easily reduced by the blow than the coarse particle, up to the point where the total resistance to crushing of the combined smaller particles exceeds that of the coarse particle; the weaker fail first. Note how increasingly difficult it is to break the coarse pieces as the material is ground longer and with finer surrounding product; note that the presence of a slow-grinding oversize did not appear until the mill had been run at least three minutes; the flattening of the 3½ curve between the 14 and 48 mesh indicating the retarding of action on the coarse, more clearly shown in the four-, six-, eight,- twelve,- and twenty-minute curves. It is probable that the feed (minus-2 plus-8) was too coarse for the mill, which was 8 in. diameter with 1-in. balls. Certain other tests on *finer feeds* practically eliminated the reverse curve.

(d)—In any crushing operation on mixed feeds, a greater amount of coarse pieces will be broken down in the first period of time than in any subsequent period of time; a greater amount of any size of the product will be produced during the first period than in any subsequent period. From the curves the following capacities through the sizes specified are obtained in one minute, for each of the periods from the start of crushing:

14 mesh—80, 27, 26, 8, 9½, 3½, ¼
48 mesh—40, 30, 28, 12½, 13½, 4, 1
200 mesh—18, 14, 15, 10, 15, 10, 5

(e)—In any crushing operation,, there will be an increasingly greater amount of energy expended upon the finer and probably finished product as the period of crushing is increased. It may be recalled that in a preceding paragraph in this article, when it was shown how absurd the theory of Kick was made by these tests, I did not follow right up with another clean-cut proof for the Rittinger law. Before looking at Table II please notice the way the curves of screen size extend out into the vague and unknown minus-200 mesh sizes, and consider which of these areas would be proportionately increased by such extension and which proportionately decreased. The use of the last two columns in Table II will be described later; they are largely speculative, and can be considered only as suggestive at this time.

TABLE II—SURFACE IN MESH-GRAMS IN 200 GRAMS PLUS 345 RECIPROCAL

Minutes	Per Minute, Total Period	Per Minute, Last Period	Per Minute, Above 45 Deg.	Per Minute, Above 20 Deg.
1	11,000	11,000	3,125	4,875
2	9,375	7,650	2,875	4,250
4	8,325	7,275	3,412	5,500
6	6,950	4,200	2,900	5,150
8	5,250	5,400	2,960	5,655
12	5,200	2,500	2,500	5,300
20	3,375	990	.....	.....

The reader will surely agree that to consider simply the areas within the diagram as drawn as representing the relative work of crushing would be unreasonable, and that considerable allowance must be made for the surface to the right of the diagram, especially for the finest crushed portion. My first method was to plot on logarithmic paper (see *Engineering and Mining Journal*, April 18, 1914, page 797), and calculate from the plotted straight line down to something like 1 per cent, the mesh-grams and curves within the extended area. Luther Lennox's method, in which he estimates the shape of the curve out to 1,600 or 2,500 mesh, and assumes that the crushed-product surface beyond this point is equal to the surface in the feed between this point and 200 mesh, is another way. He does not claim this to be a scientifically correct allowance, but it is so much better than lumping all the minus-200 mesh, as nearly all others have done, that I am not disposed to

[5] "The Work of Crushing," A. F. Taggart, *Trans.* A.I.M.E., Vol. 48, p. 171.

criticize it until I am sure that I have something better to offer.

In any event, to get agreement among the mesh-tons produced per unit of work in a given time, one must go well out into the minus-200 mesh sizes. The last two columns of Table II are simply the results of an attempt to get agreement in mesh-grams per minute (or per housepower-hour) when crushing to different screen analyses, without extended calculation and from known values. The areas between the diagonal lines at 45 deg. (and at 20 deg. also), and the curves to the left of this line, are the basis of the last two columns. There were not enough data to plat the twenty-minute curve and get anything like reasonable results, so it is omitted. It probably would be as well, in using lines of this character on the Crushing-Surface diagram, to keep within the lower two-thirds of the diagram; above that point all the irregularities due to feed and other causes appear to occur. There is sufficient agreement in the last column, for the 20 deg. cut, to suggest a possible solution; however, more work must be done before it can be accepted.

(f)—The product formed in any crushing operation, beyond the point where irregular sizes of feed appear, will plot on the Crushing-Surface diagram in the form of a hyperbola with its origin at or near to the origin of co-ordinates in the diagram. These curves are of the form XY^n = constant, where X = tons, grams, per cents, or other factors; Y = reciprocal of diameter; and $n = 1\frac{1}{2}$ to 2, in this example.

The truth of the hyperbolic form may be found by plotting upon double logarithmic paper, in which procedure the hyperbola appears as a straight line. A large number of screen analyses have been tested in this manner; one of the prettiest of these can be made with the data from Luther Wagoner's experiments described on page 309 of Volume 1 of Richards' "Ore Dressing" (first edition). In the test with the Tustin mill on hard quartz, all points plotted on double logarithmic paper lie almost exactly on a straight line, n having a value of 1, exactly, in the above formula. On the talcose slate, however, the value of n is about 3, but still all points are in a straight line.

It might be mentioned in passing that the Tustin mill, to which reference is above made, is a free-discharge type of mill in which the fines have a chance to get out of the crushing zone as soon as produced. Is there any significance in the true hyperbola which results?

Here is another interesting thing about Luther Wagoner's experiments: when he crushed the hard quartz in a stamp mill, his screen analysis shows a straight line for the last four points, with a value of $n = 2$; and when he crushed the talcose slate in the stamps, the value of n became about 6. One could speculate nicely from this that n is made up of two factors, one of which is about 2 for the ratio of the mills, and the other is about 3 for the ratio of the ores. It looks as though there is some significance to these things; some future generation may find it worth while to tell us.

Increased Grain Resistance

Increased crushing resistance at certain grain sizes is given as a reason why circulating loads build up in a closed-circuit ball- or pebble-mill unit. If there was such an increased resistance and a concentration of harder grains in the classifier circuit, there should be evidence of it in the discharge line of the Crushing-Surface diagram. The waves and departures from the regular form of a hyperbola would be evidence of it. Luther Lennox, in the paper already quoted, gives a number of Crushing-Surface diagrams. He calls the particular one I have reference to "plotted according to the Tyler direct cumulative diagram method in Figs. 7, 8, 9, 10."

This is not the Tyler method; they are true Crushing-Surface diagrams. The Tyler method had the sizes backward and was strictly qualitative. These diagrams have the regular shape, and there is no evidence of any peculiar hardness in any of them except two, those of the Alaska Gold Mines Co., and for the ore designated "Morenci, Phelps Dodge," both of which have marked waves in the product or discharge lines between 65 and 150 mesh. These waves might be due to change in character of grain size, and it is possible to predict that it would take more power per mesh-ton to reduce these ores below 65 mesh than above it. But in the milling of the rest of the ores it would hardly seem correct to charge a slowing down of the crushing effect to increased resistance at certain grain sizes; better charge it to the retarding effect of a lot of fines returned by the overloaded classifier.

Crushing in Closed Circuit, or Series

The relative merits of crushing in closed circuit with a classifier, and open, series crushing have now to be considered. The closed circuit is the rule, and series crushing is resorted to only when it is impossible to get results in any other way. Most of the data available for analysis are too meager to make possible proper comparisons; either the screen analysis of the mill product is lacking, or horsepower or tonnage is missing at some point. But the preference for a single unit is the controlling factor, and faulty classification due to overloaded return circuits will be endured rather than adopting the alternative of fooling with a tandem or series system of crushing. The Crushing-Surface diagram indicates that it is advisable (economical) to cut out all of the finest 10 per cent of the feed from the first mill and pass it on to the second; to have increasingly greater classifying capacity as finer material is classified; and probably to discharge a finished product from the third mill (I would like to say fourth or fifth mill to hear them "holler") without further classification.

Of course, "old theoretical" doesn't stop to consider that smaller crushing units would take more power and attention than large ones, and would entail the added complication of more classification and such frightful things as bucket elevators. All he can say is that competent engineers are capable of designing reliable elevators, and that a series system will give better classification for economical crushing, with smaller classifier capacity, than the closed circuit will. He hopes to get hold of a little more closed-circuit data than are available at present. Perhaps analyses will then show that the data that he has been studying are out of date and hold only for isolated cases, and that the work is as efficient as can be expected.

In this article some probable *laws* of crushing have been referred to; it would have been better to have called them the *phenomena* of crushing, but perhaps an extreme term like that will bring about a discussion of some of these "laws" better than a milder statement would have done.

I know nothing of colloids, nor have I done any testing where these were involved. It has been hard to find anything definite about them in textbooks, except that they have different properties than granular slime, and also that they are little understood. So long as they are present and are the result of crushing, (so far as the millman is concerned), perhaps they could be hooked up with the laws of crushing in some way.

Now, granted the Rittinger law of surface proportional to energy, is it not fair to assume that the molecular forces which oppose the breaking of rock are electrical in their nature, and do not appear as such when the large pieces we deal with in rock crushing are considered; they are small compared with the volume of the rock. But when the hundred thousand and million mesh stuff is produced, and some of this probably is produced in every break, the ratio of these resisting forces to the volumes of the particles is so great that the energy spent takes the form of dominating electrical charges on the particles, causing them to coagulate or not to coagulate, or whatever it is they do that isn't nice.

In other words colloids are particles of such fineness that the energy absorbed on the surfaces, caused by breaking, is of such intensity (owing to the ratio of surface to weight) that it appears in the form of electrical charges which offer resistance to the force of gravity. Thus, colloids may be tied up with Rittinger's law, and perhaps they may prove the truth of the law better than any other way yet attempted.

Manganese Situation in Transcaucasia

There has been practically no new mining of manganese in Transcaucasia for the last few years, partly because of difficulties with labor but more particularly because of the general political and economic situation, according to *Commerce Reports*. Mine owners have not felt inclined to invest money in labor and other operating expenses with little or no probability of being able to profit or even to reimburse themselves by sales of manganese.

In July, 1919, the Menshevik government of Georgia, in place of an out-and-out nationalization, organized the so-called "Temo" Export Manganese Co. by combining twenty-seven different companies—two English, one French, two Belgian, nine Greek, two Armenian, one Russian, and ten Georgian, the ten Georgian companies representing 38 per cent of the mines. The formation of this combination did not result in any new mining, but did result in the sale abroad of certain manganese stores already on the top of the ground. From July, 1919, until February, 1921, the "Temo" company is said to have exported and sold abroad 75,000 to 80,000 tons, of which 75 per cent was washed manganese. The proceeds of these sales went in part to the Menshevik government of Georgia, and the remainder was divided among the different manganese companies.

At the present time there are said to be 60,000,000 poods (sixty-two poods equal one ton) of manganese on top of the ground at the mines in the Tchiatouri region, of which 35 per cent is washed manganese. There are also said to be 8,000,000 poods already at the port of Poti, on the Black Sea, convenient for shipment by boat. The mines are in a neglected condition, many roofs having fallen in, so that in some of the mines a year's work would be necessary before new manganese could be taken out. Under the circumstances, it appears safe to predict that no new mining will be undertaken so long as political uncertainties continue. At Tchiatouri there are twenty-eight manganese-washing installations, but none of these are working. Also, the manganese on top of the ground at Tchiatouri can probably not be transported to Poti (nine hours) because of the condition of Transcaucasian railways. Therefore the only manganese stocks immediately available for sale are the 8,000,000 poods already at Poti.

One shipload of 7,000 tons is now en route from Poti to Rotterdam; 4,000 tons of the cargo is already sold at a price of about £16 per ton, the exact price to be based on the analysis which will be made after the arrival of the manganese in Rotterdam. A representative of the "Temo" company states that the balance of the cargo is not yet sold. As soon as arrangements can be made for ships the company is planning to send a shipload of manganese to London and another to New York. The price for ordinary Transcaucasian manganese ore (48 to 52 per cent manganese) is said to be £8 per ton. According to a recent report, as yet unconfirmed, a ship is en route from New York with a load of flour which may be exchanged for manganese.

Wisconsin Zinc Ore Shipments in 1921

By J. E. KENNEDY

Written for *Engineering and Mining Journal*

Shipments of zinc ore from the Wisconsin zinc district in 1921, compared with those of 1920, are given in the accompanying table. The stock of blende concentrates in bins at the end of the year 1921 in terms of 60 per cent zinc ore was 25,000 tons. Twelve concentrators operated during 1921, but of this number only one, the North Unity, operated steadily throughout the year.

WISCONSIN ZINC-ORE SHIPMENTS

In Short Tons

	Net to Smelters		Gross From Mines	
	1920	1921	1920	1921
Highland	2,551(a)	.....(b)	2,551(a)	.....(b)
Linden	50	.....	1,869	.....
Mifflin	316	.....	29,405	12,174
Mineral Point	25,592	4,964	.....	.....
Platteville	1,887	220	1,887	220
Cuba City	18,289	5,898	11,278	1,848
Benton—New Diggings	14,372	.....	50,501	2,269
Hazel Green	.....	.....	4,467	146
Shullsburg	.....	.....	3,024	.....
Galena, Ill.	.....	.....	17,966	8,324
Totals 1920 and 1921	63,057	11,082	122,948	24,981

	Net to Smelters	Gross From Mines
1919	100,135	164,731
1918	120,854	189,058
1917	148,766	247,993
1916	133,035	219,118
1915	104,670	163,916
1914	84,836	134,362
1913	76,017	105,887
1912	99,409	119,280

(a) Crude unmilled carbonate. (b) About 400 tons low-grade carbonate produced in 1921, but none shipped.

Carbonate deposits of Wisconsin district are apparently exhausted.

Lorraine Iron and Steel Industry Improving

By Reuters Agency

The *Journal Industrielle* learns from Metz that arrivals of coke for the iron and steel industry show a considerable improvement, although still variable and insufficient. The average for the Moselle region in a recent period was 5,000 tons daily. A certain number of blast furnaces have been relighted, and the situation is the same as at the middle of December when twenty-four furnaces out of sixty-six in the Moselle region were in operation.

Valuation of Placer Deposits*

BY WILBUR H. GRANT

*Contributed for publication to *Engineering and Mining Journal.*

THE ARTICLES by Gerald H. Hutton, "Valuation of Placer Deposits" (*Mining and Scientific Press*, Sept. 10, 1921, p. 365), and by Charles W. Gardner, "Drilling Results and Dredging Returns" (*Engineering and Mining Journal*, Oct. 22 and 29, 1921, pp. 646 and 686), indicate that present methods result in rough approximations of the value of placer ground. Mr. Gardner's article intimates that the present methods cannot be improved; that the judgment of experienced men is better than attempts to improve the methods, and that the results obtainable are satisfactory. Mr. Hutton's article contends that valuations made by present standard methods are not satisfactory; that methods of sampling and valuation should be evolved which will increase the accuracy of the basic data and eliminate personal judgment and guesses as much as possible, to the end that valuations of placer deposits thereby obtained will more closely approximate dredge recoveries.

The questions at issue are the following: Are the valuations of placer deposits by present methods sufficiently close to dredge recoveries to justify their use as a basis for financing the dredging projects? Can the accuracy of valuations be increased commensurately with an increased cost for the investigations? Can the methods of sampling and valuation be improved so as to obtain consistently closer approximations to actual values of the deposits without appreciably increasing the costs of the investigations? What is the logical order of approach to the problem of accurately valuing placer deposits?

ARE PRESENT METHODS SATISFACTORY?

Mr. Gardner presents specific data which show that the dredge recovery varies from 31 to 290 per cent of the drill-hole valuation of placer ground. It is probable that if the results of all investigations were available still wider variations would be found. Mr. Gardner assembles his records on the sampling of 3,743 acres of placer ground where all necessary data for valuation were complete. The aggregate areas were drilled by 1,749 holes, or one hole to every 2.1 acres. The average value per cubic yard obtained by drilling was 15.4c. and the average dredge recovery 13.55c., or 88 per cent of the valuation computed from drilling. This is as close an approximation to the value in the combined areas as miners and investors could expect. The different parcels of ground included in the summary vary from a gain of 41.6 per cent to a loss of 54.4 per cent. The investor who happened to finance the property where the gain was 41.6 per cent might not be satisfied with the accuracy of drill-hole valuation, but would undoubtedly be pleased with the returns. The investor who financed the property which showed a loss of 54.4 per cent would naturally be entitled to a grievance against valuating engineers and their methods and to a disappointment for the discrepancy.

Mr. Gardner states that with the same data different engineers would check closely on their estimates of yardage, but would vary greatly in their estimates of gross values and net profits. He says, further, that the results from additional interspaced holes, or holes but a few feet away from those already sunk, would vary so greatly that decidedly different valuations would be obtained by using the new set of holes in the computations, even if sunk by the same crew. This suggests that the blame for inaccurate and inconsistent results would be placed more on the methods in vogue than on the investigator. The investigators are, however, responsible for perpetuating the present methods which permit such incorrect valuations.

It is probable that the present methods of testing any type of placer ground are satisfactory only to the careless investigator or the adventurous investor. Details of the methods of acquiring the data by drilling and computing from data acquired should be improved and standardized. The standard number of holes used is satisfactory for uniform deposits; the number, in my opinion, should be increased about eight times for ordinary deposits and the drilling method should not be used for coarse gold deposits in steep narrow streams.

ACCURACY IN RELATION TO COST OF INVESTIGATION

The standard practice is to drill not more than one hole to the acre, and frequently fewer holes than an average of one hole to the acre are put down. Mr. Gardner estimates that with a 6-in. Keystone drill, one hole to the acre would be equivalent to taking a sample 1 in. square in an area of a vein 100 ft. long and 9.86 ft. wide. This is one of the most startling facts brought out. It is the average practice in sampling veins by cuts to take samples spaced every 5 ft. along the strike and dip of the vein, on four sides of 100-ft. blocks, if possible, the cuts being 3 to 4 in. wide and 1 in. deep, at right angles to the lines of mineralization, and taken across the veins in as many separate samples as is necessary to represent each variation in the mineralization. It is evident, therefore, that the valuation of placer deposits can never be expected to be as close an approximation to actual value as is obtained by valuing ore in place unless the quantity of material in the samples is in the same proportion to the quantity of material in the deposit in each operation.

The probable conclusion as to the necessity of increasing the cost of investigation would be as follows: The increased cost is not warranted where deposits are being sampled which contain a fairly uniform distribution of relatively fine gold and gravel. A considerable increase in the number of drill holes and a consequent increase in the cost of the investigation are warranted in the average type of deposit, and the increased accuracy obtained will be in proportion to the cost of the investigation. Where the deposit contains coarse gold erratically distributed, no system of drilling is satisfactory, no matter how many drill holes are sunk in the deposit. Such deposits should be tested by some other method.

When a valuation of a given placer deposit is assumed, there should be as clear an understanding as possible between the investor and the valuing engineer as to the permissible cost of the investigation, and the investor should not expect from the engineer any greater degree of accuracy of valuation than the fee paid permits.

*Presented at a meeting of dredge operators at Hammonton, Cal., Dec. 21, 1921.

Each variable factor in the present method of sampling and computing the value of placer deposits is more or less related to some other factor in the process. There are, however, fifty or more fairly distinct factors. Such an array indicates that many mistakes and errors may occur in an investigation.

In the gathering, interpretation, and computation there is a wide variation among engineers. Leaving aside the variations in the irregularity of occurrence, different engineers will get different results from the same drill hole, as they use different methods of estimating the amount of gold, the quantity of material in the core, and other data for determining the "constant." In addition, there is a still greater variation in the use of acquired data. Correct methods for gathering drill-hole data accurately have not been worked out from experience nor for valuation from the acquired data, which indicates that there is opportunity for engineers and miners interested in gold dredging to collaborate. They should contribute their experience into a common pool, and work out the details for developing standard methods of acquiring basic data, for computing valuations from such basic data, and for disseminating such standard methods among those who evaluate placer deposits.

Engineers should endeavor to balance all parts of their investigations so that each variable factor is determined with an equal degree of accuracy. As the amount of material in a drill hole sample is only a small part of the whole placer deposit, no great number of improvements in the refinements of the mechanical details of sampling and computation would have nearly as great an effect on the final results as has the irregular occurrence of the valuable metal in the gravel. Consequently, the deliberate or accidental location of holes has vastly more influence on the valuation of the deposit than all the other forty-nine or more variables put together.

It appears, therefore, that the most effective way of improving the present methods of sampling and valuation, without greatly increasing the cost, is to determine as definitely as possible the character and occurrence of the valuable metal in the deposit and change from a system of mechanically and uniformly spacing the holes to a system of decreasing the number of drill holes where the valuable metal is most uniformly distributed, and increasing the number where it is most irregular. If this cannot be done by studying the general features, such as the source of gold in place, topography of the bedrock, nature of water flow which brought in the material, and like factors, it can best be done by taking a large interval between holes first and where necessary decreasing the interval, first across the direction of flow and then along it until the valuation by the law of averages checks satisfactorily.

A further conclusion is that it is doubtful if all the suggested improvements will give consistently close approximation of actual value in the most common deposits without increasing the number of holes, which involves increasing the cost of the investigations.

Controlling Factors

The best sampling methods which give the closest approximation to the recoverable value are those whereby as many as possible of the variable factors involved in the estimating are determined as accurately as nature and the resources of the investor will permit, thereby eliminating as much guesswork on the part of the engineer as is feasible. Both in ledge and placer deposits there is a wide variation in the character, occurrence, and quantity of the metal. In some occurrences it is uniform, in the majority it is uneven, but not excessively so, and in others it is extremely irregular. It seems clear to me that the nature of the occurrence of the metal in the deposit is by far the most important factor in determining the methods of sampling and of valuing the deposit. The discriminating engineer will recognize this feature and use it as a guide in his method of sampling. He will also recognize the limitations in the accuracy of sampling and estimate the hazards of proceeding on the valuations placed on a deposit as a result of the nature of occurrence of the metal and the methods of sampling used.

Methods of Approach to Problem

Assuming that valuable metal has been determined to exist in an appreciable quantity in placer gravel, the next step to take is to determine every possible feature respecting the genesis of the deposit which bears on the occurrence of the metal, and interpret the bearing of these features on the choice of a method of valuing the deposit by sampling. After such data and other general features which apply to the particular deposit under examination have been observed and interpreted, an attempt should be made to classify the probable character and occurrence of the metal in the deposit. It is likely that such data will assist the investigator to determine more or less approximately the quantity, size of particles, and occurrence of the valuable metal in the deposit. It is possible that some deposits can be classified on the basis of more or less uniform occurrence of the metal. The majority will probably be classified on the basis of irregular distribution of the metal, but not excessively irregular, and some deposits will be too irregular to permit of sampling by the ordinary methods of drilling.

The first type occurs most frequently in flat countries some distance from the foothills, where the bedrock is probably uniform and the gold and gravel are fine. The second type occurs between such flats and the mouths of the gulches down which the material had been transported or at extensive flat places along the course of streams. The third type is found in the steeper narrow streams.

Such a study will suggest a definite or tentative method of sampling. Other features which will be involved in deciding on the best method, such as the amount of money available for the investigation, the accessibility of the deposit to transportation, and other pertinent factors, must also be taken into consideration. These limiting conditions will commonly modify the methods which the natural conditions indicate to be the most desirable.

The tentative system, where the general conditions do not suggest a sufficiently definite character of the occurrence of the metal, would possibly be to lay out pilot drill holes across and along the direction of deposition of the gravel in the areas. The next step would be to increase the number of holes across the prevailing direction of flow of the material, and finally to increase the number of holes along the direction of flow of the material, and so on until the complete system of sampling has been established.

There are relatively few flood plain placer deposits where the gravel and metal occur in fine condition and uniformly deposited. Such deposits can be sampled with

a reasonable degree of accuracy by the present number of holes, but the methods should be improved. The majority of placer deposits have an irregular occurrence of the valuable metal, but not excessively so. These cannot be evaluated satisfactorily by the present methods. The number of samples or drill holes should be either increased approximately to secure the same degree of accuracy as is obtained in vein sampling (at an increased cost) or a large factor of safety should be placed on the results.

Certain coarse-gold types of occurrence cannot be evaluated accurately by any method of sampling now in use. Such deposits lend themselves to simple tests by panning to determine the character and occurrence of the metal. This should be followed by guesses made by men experienced in the dredging of this type of deposit, with the definite understanding of the degree of the hazard to the investor. In other words, no method or variation of sampling methods can consistently furnish data from which accurate valuation of all types of placer deposits can be made. Some deposits can be evaluated accurately, most only approximately at a permissible cost, and some merely by guesses. The accuracy will increase as the ratio of the quantity of the sample to the amount of material in the deposit increases.

The investor should either increase the cost allowance for the investigations of placer deposits which contain irregular occurrence of valuable metal, or the engineer should increase his factor of safety when making his recommendations for the exploitation of the deposit. Those engaged in the business should collaborate more and devise methods whereby identical figures can be obtained by different engineers drilling under the same conditions, and, given the same data, they can arrive at a common constant and the same valuation.

Quicksilver Production Declined in 1921

Preliminary figures showing the production of quicksilver in the United States in 1921, compiled by F. L. Ransome, of the U. S. Geological Survey, give a total of 6,339 flasks, as compared with 13,392 flasks in 1920. Of this output 3,094 flasks is credited to California, 3,144 to Texas, 100 to Nevada, and 1 to Idaho. So far as could be learned, Oregon produced no quicksilver in 1921.

In California seven mines reported production, but the output from all but the El Senador mine, of the New Almaden group, was small. The New Idria mine, for many years the largest producer of quicksilver in the United States, was idle in 1921. In Texas, the Chisos was the only mine that remained continuously productive, but a small output was expected in December from the Mariscal mine, near McKinney Springs, and is included in the total. In Nevada about 100 flasks was obtained in the Pilot Mountains, east of Mina. The single flask reported from Idaho was retorted incidentally to development work in the Yellow Pine district, Valley County. During the year the United Mercury Mines Co. acquired over 100 claims that were formerly held by the Idaho Quicksilver Co., the Monumental Mercury Mines Co., and other companies in the Yellow Pine district.

In Oregon, the War Eagle Mining Co., operating what was formerly known as the Rainier mine, in Jackson County, completed a twenty-five-ton Scott furnace in 1920, but is not known to have produced any quicksilver in 1921.

The average price of quicksilver in 1921 per flask of 75 lb., as quoted by *Engineering and Mining Journal*, was $45.46.

Never before has the quicksilver-mining industry in the United States sunk to so low an output. The first recorded annual production was 7,723 flasks, in 1850, and from that year to 1920 inclusive the annual output has been 10,000 flasks or more—in fact, in only five years has it been less than 20,000 flasks. In 1859 it was 13,000 flasks; in 1860, 10,000; in 1908, 19,750; in 1914, 16,548; and in 1920, 13,392. The maximum output, that of 1877, was 79,395 flasks. The output in 1921 was thus the smallest on record. The average price in 1921, although of course much lower than for the years during and immediately after the war, nevertheless compares favorably with pre-war prices. The cost of production, however, has not declined so rapidly as the price, and no large bodies of ore are now known that are comparable in tenor to those that were exploited when quicksilver mining in the United States could be considered a flourishing industry.

Zinc-Lead-Silver in Upper Silesia

It is impossible to state exactly what part of the production of zinc and lead ore in Upper Silesia falls to Poland and Germany respectively, as the League of Nations decision provides for a final delimitation of the boundary on the ground and through the area where the mines are situated, according to *Commerce Reports*. A preliminary estimate states that the mines which will fall in Polish territory produced in 1913 almost exactly 500,000 tons of these ores, and those in the German part 61,000 tons. The production fell rapidly during the Great War, and the total for all Upper Silesia in 1920 was only 288,000 tons. These figures include calamine, zinc blende, and lead ore.

Practically the entire zinc-smelting and manufacturing industry will be in Polish territory. All of the thirteen roasting plants (about 250 furnaces), the sixteen zinc-smelting plants (316 furnaces), and the two lead smelters will be in Polish territory, together with five of the eight zinc-plate rolling mills. The production of raw zinc in Upper Silesia fell from 169,400 tons in 1913 to 81,400 tons in 1920. The production of lead in the two lead- and silver-smelting plants which are now in Poland was 41,800 tons in 1911 (the maximum year), but only 17,200 tons in 1920, and the silver production fell from 10,620 kilos to 3,110 kilos. The total output of zinc plate in 1913 was 49,200 tons, of which the mills now allocated to Poland produced 42,500 tons. The output of all these plants in 1920 was 34,170 tons.

Production of Bauxite in 1921

The production of bauxite in the United States in 1921 is estimated by the U. S. Geological Survey at approximately 130,000 long tons, as compared with 521,308 long tons in 1920, a decrease of 391,308 tons. This great decrease in the production of bauxite is largely the result of the curtailed demand for aluminum, particularly aluminum used in the automobile industry, though the curtailed consumption of chemicals containing alumina lessened the output of some of the mines, particularly those that are situated in the Georgia-Alabama field.

BY THE WAY

Schleichegrieben Outpointed

Just as there is more than one way of killing a cat, so there are various ways of getting the fat from a pig. From Prussia comes a tale that savors of Teutonic scientific achievement, but which in reality makes us almost suspect that the Prussians have forgotten the precept taught them when lisping babes, that they should be kind to the lower animals. It seems that in Schleichegrieben, that charming spot renowned among tourists for its beautiful, enchanting, Circe-like maidens, the farmers have adopted a practice of vivisecting their four-footed friends, not for the advancement of science, but because there is money in it. But they do not kill them. No longer are the pigs of Schleichegrieben led to the slaughter when their days are fulfilled. No longer are they cut down in their prime of life simply at the behest of the scale beam. Instead they are neatly and scientifically opened with precision at the critical point of attack, a layer of fat is removed, and then with equal precision they are neatly and scientifically closed up again, and turned out to grunt and root and whatever else that the pigs of Schleichegrieben do in order to grow a new layer of fat.

How essentially Teutonic, and how much better we do it here! Sad indeed would be the day when Yankee ingenuity would fail to triumph over all. Shall the bald-headed eagle yield to the two-headed eagle? Never! Not while there is any distinction left in a bald head. By the power of our home-made hooch, never! The scene changes.

Years ago, and not so very long ago at that, a little child was born in Osawatomie-by-the-Sea, Nebraska. Victor Carolus Pumpernickel did not look like much at the time, and few suspected that the germ of scientific greatness was in him, simply awaiting a suitable medium in which to develop. And so the years rolled by. In the course of time this promising youth found himself, in high top boots and corduroys, at a famous mining school. Here, studying under a world famous authority, he became interested in the problems of the domestic oil-shale industry, as yet almost non-existent, but having simply tremendous, staggering possibilities. The equipment of the school included a fairly large retort of special design for testing oil shale on an almost commercial scale. This was built outdoors on the campus at the foot of a short declivity, so that the shale could be readily charged by passing it in barrows over a runway bridging the short gap between the charging door and the top of the slope. It so happened one day when a test was being run that a pet pig, the mascot of the Varsity eight, while rambling over the campus, ventured onto the charging floor, so to speak, in spite of the safety warnings, and fell in. Loud were the squeals probably, but help was far away, and considerable time elapsed before piggy was rescued, very hot and reeking at every pore with perspiration, but otherwise none the worse and still able to function as a source of inspiration for the students. Later when Pumpernickel came to measure the amount of oil recovered, he noticed something floating on the surface. On closed examination he found to his intense astonishment that it was rashers of bacon. Incredible though it seemed, there they were. He quickly sensed the importance of the occurrence. He had actually effected a fractional distillation of the pig, and the particular conditions under which the retort had been operating had been just sufficient to effect a partial synthesis subsequent to condensation. Pumpernickel had carefully preserved all the data of the run. Upon reproducing the conditions he found he obtained the same result. Eureka! he had found it. Croesus! he would be rich for life. He found that the pig showed a decrease in weight after each treatment, which was almost exactly equaled by the weight of bacon recovered.

To make a long story short, the Heat Treatment Pork Packers, Inc., has been organized, capital having been readily secured. Further research has proved that oil shale is not essential to the process. A retort has been developed which is really a chamber large enough to permit several hundred pigs to be driven into it at once. The bacon will be produced in rashers ready for boxing, and may soon be expected on the market. The pigs are turned loose to feed after each reduction. The process is beautifully simple and gives precise results. Science and industry have thus advanced another step hand in hand. Mr. Pumpernickel has been advised that his alma mater will bestow its valued LL.D. on him at its next commencement.

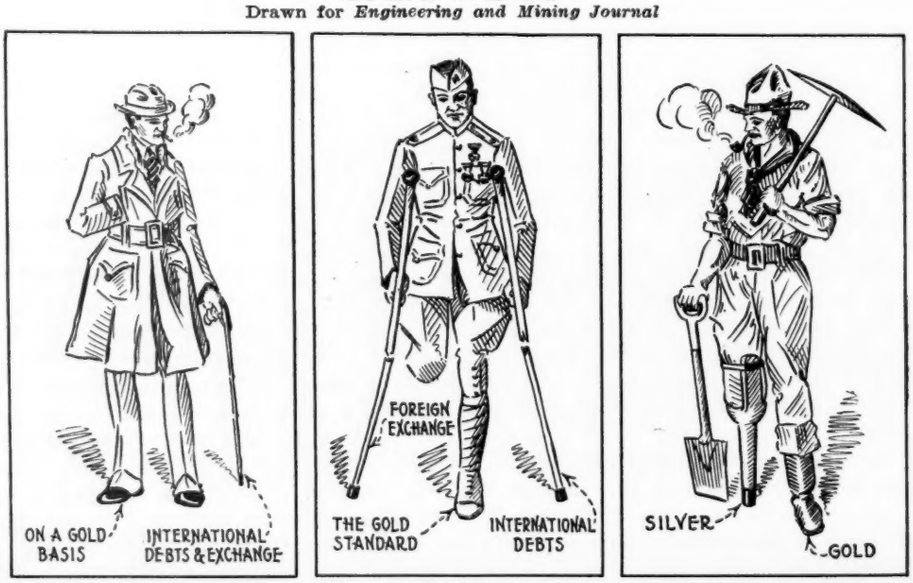
A Boring Tale

A wildcat oil well south of Porterville, Cal., now down 1,200 ft., is said to be producing fish from a subterranean stream.

The World's Business

By HUGO W. MILLER

Drawn for *Engineering and Mining Journal*



HANDY KNOWLEDGE

Neighborly Chats With the Foreman

Condition of Tools

BY DUNCAN MACGREGOR

Written for *Engineering and Mining Journal*

Not long ago, Jim, I went through a large lead-smelting plant. I was interested in observing the work and loitered by a gang rushing "muck." One of the men stopped his wheelbarrow opposite me and said "Look at that wheelbarrow, MacGregor. How can a man do an honest day's work with that thing?" One bearing was out of place, resulting in a crooked wheel. One leg and a handle were bent. It was obviously in bad condition. I agreed with him that it was a decided handicap. That company was paying $5 for eight hours' work and putting an Oregon boot on the man in the shape of a battered wheelbarrow at the same time. It seems to me that the mining industry has to pay for a certain amount of this stupidity all the time. In this instance both the foreman and the company were to blame, but the workman's aspersions were directed at the company.

It seems to me, Jim, that there's a lesson in this instance for both the foreman and the superintendent. How often are worn-out shovels kept on the job? It costs more to keep a worn-out shovel busy than a good one. How often is the steel supply allowed to run down so that a machine man is pounding a dull drill and breaking steel or even damaging his machine? There's a lot that can be done toward keeping small tools up. When you are paying a full day's pay to keep a tool busy, it pays to see that the tool is a good one.

Tramming a mine car is hard work, but if the car is in good mechanical condition and properly lubricated a man will not go off shift feeling as if he has put two days' work into one. Keep your repair men on their toes, Jim, and your cars, shovels, and drills in first-class shape. Poor tools and bad ladders increase your labor turnover, and if you want to keep your good men, one excellent method is to see that they can't kick over tools.

Increasing Rope Capacity of Hoist

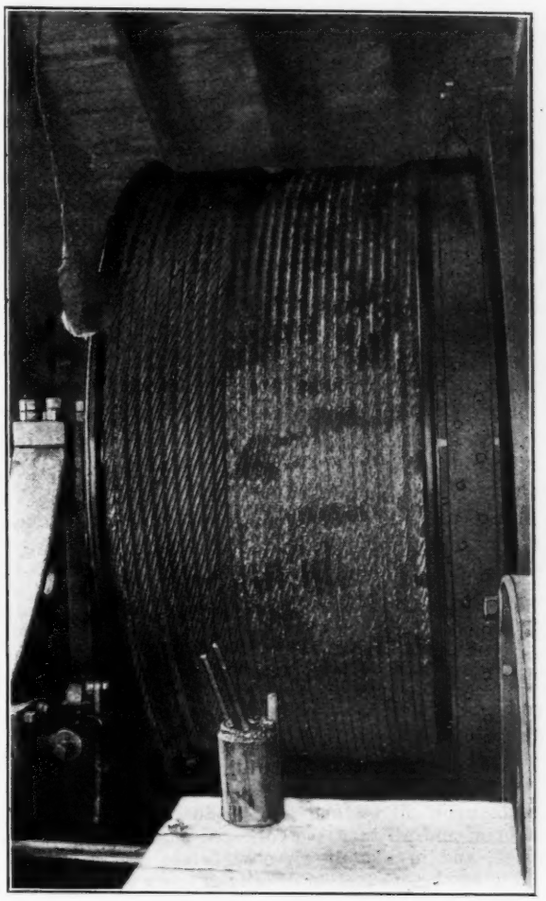
BY H. H. HUNNER

Written for *Engineering and Mining Journal*

A double-drum mine hoist with drums of 30-in. face and 6-ft. diameter was ground for 1½-in. rope. The drums would carry 1,000 ft. of 1½-in. rope in two layers. This hoist was put into service on a shaft-sinking job where each drum had to carry 1,700 ft. of 1½-in. rope. The new rope was put into service after the shaft had been sunk 650 ft.

The rope was first wrapped on the drum as it was, taking care to get a tight, snug wind, as each layer was put on. The 1,700 ft. occupied three and three-quarter layers on the drum. This method proved a failure in about three weeks. The rope had become so jumbled up in that time that it was necessary entirely to rewind.

Two ⅛-in. plates 29½-in. wide, each bent to cover one-half the drum with an inch or two for lap, were next hay-wired to the drum. This gave a smooth face for the bottom layer of rope, and it was thought would permit winding the center layers so tightly the rope could not squeeze through. This wrapping was done as carefully as possible, the rope being kept under a tension greater than it would have with a loaded skip. In two days' time it had crowded the two bottom layers over at one place so that the rope cut down to the plate.



HOISTING ROPE HELD IN PLACE WITH LEAD

The rope was again rewound, and the two inside layers were leaded up after winding each layer. This held the rope firmly in place and the two outer layers reeled up in perfect form.

In applying the hot lead no attempt was made to seal in the outer half of the rope coils. The lead was poured from a hand ladle, the man standing on the top of the drum and pouring straight across from flange to flange of drum at intervals about a foot apart on the circumference. Just enough lead was used to fill spaces between coils up to about half the thickness of the rope. In pouring, a thin coating of lead was given most of the upper half of the two inside layers of rope. This served as a bond between the two layers in pouring the second wrapping and also as a cushion for the rope between the active and reserve portions. As the shaft deepened and the leaded-in parts of the rope came into active service, the surplus lead was easily broken off.

THE PETROLEUM INDUSTRY

Drilling in White Point Gas Field

SPECIAL CORRESPONDENCE

The White Point Production Co. is drilling in the White Point gas field of San Patricio County, Tex. This well will be drilled below the gas-bearing strata in an endeavor to find oil. A second rig is being set up a quarter of a mile southeast of the producing gas well, and a well will be drilled to supplement the gas supply. This company is under contract to drill three more wells on the property of the White Point Development Co. and four on that of the White Point Oil & Gas Co. The White Point Development Co. has cleared a pipe-line right of way to the shore of Nueces Bay, and material is being received for its pipe line to Corpus Christi to supply that city with natural gas.

Production at Mexia, it is believed, has passed the peak, although some extensions to the field are being made. The highest production was a daily average of 190,000 bbl. one week in January. This has now fallen to about 145,000 bbl. daily, and few big gushers have been brought in recently to make up for the decline in the old wells. The field is being extended slightly to the north, and considerable drilling is under way in the Wortham district. The recent completion of the Joe Kennedy No. 2 well of the Humphreys interests, with an initial production of 5,000 bbl., has extended the field one and one-half miles toward Groesbeck.

Oklahoma Oil Tax Bill Introduced

WASHINGTON CORRESPONDENCE

Chairman Snyder of the House Indian Committee has introduced a bill providing an oil tax in Oklahoma as follows:

"That the State of Oklahoma is authorized, from and after the passage of this act, to levy and collect a gross production tax upon all oil and gas produced in Osage County, Oklahoma, and all taxes so collected shall be paid and distributed, and in lieu of all other state and county taxes levied upon the production of oil and gas as provided by the laws of Oklahoma, the Secretary of the Interior is hereby authorized and directed to pay through the proper officers of the Osage Agency, to the State of Oklahoma from the amount received by the Osage Tribe of Indians as royalties from production of oil and gas, the per centum levied as gross production tax, to be distributed as provided by the laws of Oklahoma."

Advantages of Diamond Drill in Oil Prospecting

The diamond core drill, common in mining, may become useful in testing out prospective oil fields, according to the U. S. Bureau of Mines. Recently the value of the diamond core drill was proved by the successful completion of a well in Mexico. It has certain advantages over the other drilling systems, and these have apparently been overlooked in oil drilling. The equipment is lighter and can be transported more easily, drilling should be cheaper with the improvement in equipment, and it furnishes a continuous core of the formation passed through.

Petroleum Investigations of the U. S. Bureau of Mines

D. B. Dow, of the Bartlesville Experiment Station of the U. S. Bureau of Mines, has begun an investigation of blended products containing natural-gas gasoline. At present the natural-gasoline manufacturers are having difficulty marketing their product, because of the overproduction of gasoline, and of the prejudice against natural-gas gasoline blends. By proper selection of blending material and use of the proper amounts of natural-gas gasoline, it may be possible to produce a mixture with characteristics similar to those of "straight run" products. A study is being made by the Bureau of the relation between vapor pressures and rates of evaporation for straight-run and blended products.

An experimental refinery consisting of three 1-bbl. stills and one 5-bbl. still, condensers, run-down tanks, and other fixtures has been constructed at the Bartlesville station, and is now being used in work on refining problems. Use was made of this refinery in investigating the recovery of gasoline from still vapors and in the production of special products for blending with natural-gas gasoline.

The investigation relating to the recovery of gasoline from uncondensed still vapors has been completed, and a report is being prepared. Practically all the refineries in the country that have installed equipment for obtaining gasoline from still vapor have furnished data on the type and process used, whether compression or absorption, the amount and nature of the vapors handled, the yield and quality of gasoline recovered, and other points.

New Pipe Lines for Natural Gas

SPECIAL CORRESPONDENCE

Announcement has been made that plans have been perfected for the construction of a pipe line from the Lost Soldier and Mahoney Dome oil fields in Wyoming, to convey natural gas to Denver and intervening northern Colorado towns. The pipe line will be 240 miles long and will first connect with the immense wells in the Mahoney district, where a single well is rated with a capacity of 40,000,000 cu.ft. of gas every twenty-four hours.

The line is to be built by the New York Gas Co., a corporation controlled by New York and Wyoming capitalists, and the gas is to be sold to existing gas companies operating in Denver, Boulder, Fort Collins, Greeley, and other northern towns.

Argentina Needs Well Equipment

Argentine purchases of oil-well equipment and supplies promise to be important during the present year, according to advices received from Edward F. Feely, commercial attaché at Buenos Aires. Large manufacturers are urged to keep on the ground qualified representatives thoroughly acquainted with the technical features of the business.

Technical Papers

Mine Power Plants—*Proceedings* of the Australasian Institute of Mining and Metallurgy (Melbourne, Australia), Sept. 30, 1921, contains a twenty-four page paper, illustrated with many plates and photographs, describing the new power plant at the South Mine, Broken Hill. Ten Babcock & Wilcox boilers, each of 2,690 sq.ft. heating surface, comprise the boiler equipment. The machinery includes two 3,000-kw. Fraser and Chalmers Vickers turbo-alternator sets and one 1,000-b.hp. Belliss turbine-driven air compressor to compress 5,000 cu.ft. free air per minute to 90-lb. pressure.

Mine Timber—The U. S. Bureau of Mines, Washington, D. C., has issued a bulletin on "The Growing Need for Preservation of Mine Timber," *Reports of Investigations*, No. 2310, obtainable on request. The amount of timber used in the American mining industries is estimated, and the kinds used for the various purposes are noted. Increased prices and scarcity make some method of preservation desirable, and it is pointed out that this practice has long been current in some foreign countries. The bulletin does not describe the manner in which the preservation should actually be done.

Mining in Burma—"The Mining Possibilities of Burma" are discussed in an eleven-page article in *The Mining Magazine* for December. (Salisbury House, London Wall, London, E. C. 2; price, 1s. 6d.) The author, H. D. Griffiths, thinks the possibilities are bright and that the region has been neglected. Gold dredging would seem particularly attractive.

Cyanide Process—In the series of articles on the new developments in ore treatment on the Rand, being published in *The Mining Journal* (15 George St., Mansion House, London, E. C. 4; price, 8d.), the Jan. 7 issue contains a three-page discussion of the treatment of slime and the recently introduced all-sliming process.

Gold Washing—The new hydraulic enterprise of the Idaho Gold & Ruby Mining Co. near Leonia, Idaho, is described in the Dec. 20 issue of the *Northwest Mining Truth* (Spokane, Wash.; price, 15c.). The plant for recovering and treating the gravel and black sand is described. Riffles and non-oscillating tables are to be used.

Mine Ventilation—A thirty-four-page paper in the *Transactions* of the Mining Institute of Scotland (Cleveland House, 225, City Road, London, E. C. 1) discusses a new method of measuring ventilating resistances, with special reference to the operation of mine fans in combination. A great deal of theoretical matter is included. There is also a shorter paper on the testing of anemometers, the results obtained in the tests described indicating the unreliability of the anemometer when measuring low air velocities.

Tungsten—The *Proceedings* of the Australasian Institute of Mining and Metallurgy (Melbourne, Australia) for Sept. 30, 1921, contains a fifty-two page paper entitled "Notes on Tungsten, With Particular Reference to King Island Scheelite Treatment and Assays of Low-Grade Material." The introduction contains general information on the occurrence, method of milling and treatment of tungsten ores, and uses of the products. The next section describes the local treatment, which is, briefly, coarse crushing, tabling to remove such gangue minerals as quartz, and aplite, and the recovery of a garnet-scheelite concentrate. The garnet is removed by an electromagnet. The final section gives valuable information on assaying tungsten-bearing materials, of general application. The weakness of the purely acid methods, especially for low-grade ores, is brought out.

Metal Statistics—Another compilation of the Metallgesellschaft is out, under date of December, 1921. It covers aluminum, lead, copper, nickel, quicksilver, silver, zinc, and tin, giving figures for the world and individual country production, and prices for the years 1911 to 1920 inclusive. Copies of this seventy-six-page book may be obtained from the Metallgesellschaft, Frankfurt am Main, Germany. The price of the pamphlet is not stated.

Hydrometallurgy of Zinc—The *Journal* of the Society of Chemical Industry, (The Society of Chemical Industry House, Finsbury Square, London, E. C. 2; price, 3s. 6d.) in its Dec. 15 issue contains a six-page article on the "Hydrometallurgy of Low-Grade Zinc Ores." The paper is written by a Japanese and discusses the problem from a Japanese standpoint. The author describes a wet process which he has adapted, using sodium bisulphate as the solvent for the roasted zinc ore.

Canadian Mineral Production—The final report on Canadian mineral production during 1920 is now available on request from the Mines Branch, Department of Mines, Ottawa, Ont., Canada.

Economic Geology—Bulletin 715 of the U. S. Geological Survey, Washington, D. C., obtainable on request, has now been issued in complete form as "Contributions to Economic Geology, 1920." Practically all of the twelve papers which it contains have been issued separately and reviewed in these columns as they appeared.

Mining in India—The report of the Chief Inspector of Mines in India for 1920 is now available for 3 rupees from the Superintendent of Government Printing, No. 3 Hastings St., Calcutta. Most of the bulletin is devoted to the accident record.

U. S. Geological Survey—The forty-second annual report of the U. S. Geological Survey for the year ended June 30, 1921, is a 108-page book, obtainable from the Survey, at Washington, D. C., describing briefly the recent activities of the Bureau.

Book Reviews

Mineral Land Surveying. By James Underhill, Ph. D. Third edition, revised. Cloth; 5½ x 7½; pp. 237, with three plates; figs. 43. John Wiley & Sons, Inc., New York, 1922. Price, $3.50.

The United States Mineral Surveyor who conscientiously follows the principles and practice laid down in this volume will not only reflect credit upon his own work, but by reducing the cost of governmental corrections will assure the return of a goodly share of the deposit which every claimant makes with the General Land Office before a patent survey is ordered. Naturally, in a specialized book of this nature the author assumes that his readers possess a knowledge of plane surveying principles, and in the first part of his work discusses only those methods particularly applicable to mineral land surveying.

Chapter 1 is devoted to the direct solar observation, a correct understanding of which is necessary to accurate surveying. The author dwells more upon practice, calculations, and formulæ than upon theory. A surveyor looking for enlightenment upon the theory of the solar observation will not find the subject discussed in much detail and may be confused by the solar diagram on page 5, in which the zenith appears tilted to the left of the observer instead of appearing directly overhead. Probably this is an error in printing, but it makes the diagram rather confusing, which it would not have been had the zenith been centered at the top.

Chapter 2 describes the use of the solar attachment, and the third chapter deals briefly with linear measurements. The next section begins the treatment of the special problems of mine claim surveying, goes into the location and patent surveys in great detail, and is the most valuable part of the book. Specimen surveys, field notes, plats and the required governmental forms, properly executed, give a good insight into the mineral surveyor's field and office work. A useful chapter is one upon examination questions to guide the prospective U. S. Mineral Surveyor in being adequately prepared for his examination for a commission. In some states these examinations are quite difficult.

Although this is a third edition, the omission of any reference to observations on polaris, which are frequently used to determine the meridian, detracts somewhat from its completeness. Also, a future edition might well consider the inclusion of the interesting and special problems of locating the points of intersection of conflicting claims. However, the book's compactness and the valuable practical information which it contains should place it within convenient reach on the mineral land surveyor's five-foot shelf. F. E. W.

ECHOES FROM THE FRATERNITY

SOCIETIES, ADDRESSES, AND REPORTS

Spokane Convention Against Mine Law Revision

Government of Alaska from Washington Criticized—Bonus Legislation Scored—Strict Adherence to Pittman Act Advocated—Blue-Sky Bills Condemned

BY HILLIARD W. POWER

Written for *Engineering and Mining Journal*

THE twenty-seventh annual convention of the Northwest Mining Association opened in Spokane, Wash., on Feb. 14, lasting four days. Delegates from Alaska, Oregon, Idaho, Washington and British Columbia were present. Much enthusiasm and optimism were shown by the visitors as regards the outlook for their respective sections. Technical discussion and papers were not on the program, the plan being, instead, to thresh out problems affecting the legislative and the requirements of the Northwest mining industry at large. Extensive use was made of motion pictures supplied by the U. S. Bureau of Mines. Arrangements were in the hands of Frank C. Bailey, secretary of the Northwest Mining Association.

RIVERSIDE AVENUE, ONE OF THE PRINCIPLE BUSINESS THOROUGHFARES OF SPOKANE, WASH., WHERE THE NORTHWEST MINING CONVENTION HAS JUST BEEN HELD

Resolutions passed at the convention numbered fifteen and included the following:

The Secretary of State of the United States was asked to enter into diplomatic negotiations with the Government of the Dominion of Canada, with a view to securing the removal of the Canadian tariff on Canadian lead smelted and refined at United States bonded smelters. Thanks were extended to Senator Miles Poindexter, of Spokane, and to Ravenel Macbeth, secretary of the Idaho Mining Association, for work already done at Washington in this connection.

Another resolution was passed condemning the system of bureaucratic government imposed upon Alaska as conflicting, interlocking and autocratic, with its lack of co-ordination and its abundance of red tape. The resolution alleged that the result is that the pioneer operator has been driven from the territory to more attractive fields and that the tendency towards monopoly has become more marked each year by large corporate interests. It pronounced as a failure the efforts directed to conserving Alaska's resources, and asserted that they tended to monopoly. It indorsed in principle the proposal made by the Secretary of the Interior and the Governor of Alaska and their several predecessors and embodied in bills already introduced in Congress, namely that all bureaus having to deal with the natural resources of Alaska be co-ordinated and united, in so far as their activities in Alaska are concerned, under one responsible head, preferably the Secretary of the Interior, with an authorized representative resident in Alaska. It was urged that early legislation be passed by Congress providing for a return in Alaska to that liberal public land policy which has been so successful in the western United States and in Canada.

Members of the Finance Committee of the United States Senate were urged in another resolution to take prompt action upon the Fordney tariff bill.

Completion of the South Fork road, which serves a rich mining district of southern Idaho, was favored in another motion which emphatically advocated the completion of local roads opening up mineral and other valuable producing areas. Equally emphatic protest was made against the provision of more national highways constructed unnecessarily for the sole benefit of automobile tourists.

Admiration of the patriotism of millions of ex-service men in the United States army and navy in the late war was expressed in a resolution, which, however, stated that any legislation involving huge cash expenditures at this time should be most carefully scrutinized to make sure that economical readjustment, so essential to the nation in the present crisis, be not obstructed.

It was insisted in another resolution that the provisions of the Pittman Act be carried out to the letter and that the silver sold to Great Britain be repurchased and restored to the Treasury to the full amount specified in the bill.

The Volstead and Dennison Blue-Sky bills now before Congress were condemned.

It was urged that the American magnesite industry, now stagnant because of competition with cheaply produced foreign magnesite, be given prompt and sufficient protection by Congress, and that at least the proposed specific duty of $15 per ton be levied on foreign magnesite imported into this country.

A resolution was passed condemning the Better Business Bureau, an adjunct of the Spokane Advertising Club, for methods used in attempting to pose as an adviser to the public in the matter of speculative investments, particularly mining, and pointing out that

such an organization is less competent to advise investors intelligently than are reputable brokers and promoters who have made a close life study of the situation. The resolution also expressed the willingness of mining men of the Northwest to co-operate in any fair regulations designed to limit dishonest promotion and to protect the public against unsound investments.

The opposition expressed by the Northwest Mining Association to measures now before Congress providing for the revision of mining laws was indorsed. It was stated that mining men of the West are tired of regulations and restrictions, and prefer, for the present at least, to work their way back to prosperity through the aid of laws which are now well understood, even though imperfect, rather than to fly to evils of which they can as yet have no conception or adequate knowledge.

The work conducted by the U. S. Bureau of Mines at Moscow, Idaho, was indorsed, especially along lines of cooperative research in ore dressing and metallurgy at the University of Idaho. The desirability of increasing the scope of this work to that of a full station as soon as funds available will permit was urged.

The work of Ravenel Macbeth, secretary of the Idaho Mining Association, on behalf of tariff protection for metal and mineral industries was heartily commended.

An extensive display of minerals from the mining districts of the Northwest attracted much attention. A feature of this was an exhibit of the products of Washington magnesite plants, particularly of plastic magnesite manufactures. This indicated the possibilities of the industry along other lines of production than that of the well-known and common dead-burned material.

Mesabi Range Alumni Meet

The Mesabi Range Alumni Association of the Michigan College of Mines held a banquet on Washington's birthday, Feb. 22, at Hibbing, Minn. The principal speaker of the evening was Donald Gillies, vice-president and general manager of McKinney Steel Co. and president of the Alumni Association of the Michigan College of Mines.

Petroleum Geologists Meet in Denver

The tri-monthly meeting of the Rocky Mountain Association of Petroleum Geologists was held at the Albany Hotel, in Denver, on Feb. 9. Following a luncheon Charles T. Lupton submitted a paper on the "Pre-Cretaceous Stratigraphy of Western Kansas" and J. E. Redburn read a review of a recent paper published by John Rich on "Moving Underground Water as a Primary Cause of the Migration and Accumulation of Oil and Gas." A general discussion followed.

Canadian Engineers Meet at Vancouver

British Columbia Section of Institute of Mining and Metallurgy Holds Annual Convention—Taxation of Claims and Air Transportation Discussed

By Robert Dunn

Written for *Engineering and Mining Journal*

THROUGHOUT the annual general meeting of the British Columbia Division of the Canadian Institute of Mining and Metallurgy, which was marked by many addresses on subjects ranging from a review of the past year's mining to the oil possibilities of the Mackenzie River, not a single note with a pessimistic ring was heard. The attendance was large, many being present even from the remote districts. When R. W. Brock, of the University of British Columbia, stated that mineral wealth was the basis upon which the province must build prosperity and that if the tragedy of isolation is not to overtake it, its mineral resources must be developed and railways built, he was applauded enthusiastically. Much the same point was made by William Sloan, Minister of Mines, in the concluding speech of the meeting. If the Hidden Creek mine and the Anyox smelter could produce practically all the copper of 1921 and keep the output within range of that of the previous year, and if the Sullivan mine and the plant of the Consolidated Mining & Smelting Co. could produce almost all the lead and zinc and establish new records in respect of these metals, it was hard to conceive of any limit to mineral possibilities of the province, he said.

Lieutenant Governor W. C. Nichol, who opened the convention, said: "If our mineral resources are to be of the greatest value to us, we must ourselves own and operate to a far greater extent than we do, and not leave it all to outside enterprise." A review of mining in the province in 1921 was given by William Fleet Robertson, provincial mineralogist, who placed the value of total production in 1921 at $28,504,903, a decrease of $7,038,181. The value of the metal output was $13,232,002 and that of coal was placed at $13,272,903.

Mayor Tisdall of Vancouver expressed the hope that local capital would be invested in the province's mining prospects. William M. Brewer, resident Government mining engineer, summed up a discussion of the prospector by charging that too much education was responsibile for his increasing scarcity. The youth of today, he said, are educated to the point where, after being graduated, they contrast unfavorably the lonely life of a prospector with life in a city, where money can be earned with no sacrifice of comfort or of social opportunities.

The question of the expediency of advocating the imposition of heavier taxation on Grown-granted mineral claims or of requiring a certain amount of development work to be done each year, in place of the present tax of 25c. an acre, was discussed with spirit. A faction headed by F. W. Guernsey, a mining engineer of Vancouver, was in favor of some course different from the policy now existent, to the end that Grown-granted mineral claims held without development and obviously for speculative purposes should be so dealt with that their mineral wealth would be exploited, if not by the present owners, then by others who are willing to do so.

On the other hand, though it was generally admitted that in the well-prospected areas there are many dormant Crown-granted claims and that this may be neither expedient nor desirable, strong opposition to a change developed. C. P. Hill, of the Hillcrest Collieries, argued against the principle of adding to the taxation on non-productive property, title to which had been fairly earned by prospectors who had roughed it and were responsible for the discovery and opening up of the great mining camps of the West. Others acknowledged the blight of unworked claims but felt that a radical change in the law might do an injustice to many deserving mining men. No conclusion appeared possible, and the issue was left in suspense.

Transportation by Air an Aid to Prospecting

"Aerial Photography as an Aid to Prospecting" was discussed by Major E. MacLaurin, who claimed that the airman with the present equipment can render valuable assistance to the prospector. Large tracts of territory, he said, could be photographed in strips, pieced together and the final mosiac would permit careful study and consideration before entering the country. From this the prospector could prepare his field map, showing the drainage of the country, the best route for entry, the relative locations of mountains, valleys, lakes and other important information as to cover, rock croppings and other features. Major MacLaurin said that conditions in British Columbia were favorable to this kind of preliminary exploration.

"In my experience," he declared, "an efficient seaplane or flying boat may move almost anywhere in comparative safety, as the province abounds in lakes and rivers suitable for emergency landing places. As far as I know, little use has been made of aircraft by mining men. Except for one or two photographic surveys of oil properties in the south, the Imperial Oil Co's experiment in the Peace River country, and a flight made by Professor Bruce, of Queens University, last summer in northern Ontario, not much has been done. British Columbia is especially well suited to the operation of

aircraft. Its physical features are exceptionally rough, offering difficulties to the ordinary means of locomotion, but its innumerable lakes and rivers provide splendid natural landing places. Straightforward flying with a reliable pilot and a properly cared for machine offers a perfectly safe and sane means of travel."

The general mining and milling practice at the Britannia mine, on Howe Sound, was discussed by C. P. Browning. He said that, power being produced entirely on the property, the whole operation of mining, transporting and concentrating 2,300 tons of ore daily was accomplished by a plant that was more or less self-contained, with the exception of the smelting and refining of the copper concentrates.

Oil possibilites of the Mackenzie River were described by Prof. M. Y. Williams who recounted the results of the prospecting of the Imperial Oil Co. A gusher has been struck and capped, he said, and later the flow had declined. It was not likely that, however the field might develop, it would produce what were commonly referred to as gushers. He stated, that the company did not have to sink far before obtaining the oil.

Standardization Bulletin of A.M.C. Ready for Distribution

Every mine operator and engineer interested in standardization of mining equipment, or in improving the methods and practices in mining, will find much useful information in the Second Standardization Bulletin just published by the Standardization Division of the American Mining Congress, Washington, D. C. It contains the recommendations of the committees from the coal and metal branches, and as the committee had the views of both operators and manufacturers, the recommendations are the result of thorough consideration. The bulletin also contains the discussions of the reports which were presented at the Second National Standardization Conference in Chicago in October, 1921.

The following committees of the metal-mining branch have presented progress reports with discussions and suggestions for the consideration of the industry: drilling machines and drill steel, N. B. Braly, chairman; underground transportation, William B. Daly, chairman; fire-fighting equipment, William Conibear, chairman; mine ventilation, Charles A. Mitke, chairman, (temporary); mechanical loading underground, Lucien Eaton, chairman; mine timbers, Gerald Sherman, chairman; mine accounting, T. O. McGrath, chairman.

It is the desire of the Standardization Division of the congress and of all those who have been carrying on the work of standardization to obtain the widest possible distribution of this bulletin to the mining industry. The bulletin will be furnished on request to the American Mining Congress, Munsey Building, Washington, D. C.

The After-Effect of Igneous Intrusion*

Presidential Address of James F. Kemp, Before the Geological Society of America, Made at Amherst December, 1921

The general use of the polarizing microscope was brought into this country in the 70's but had its greatest stimulus in the next decade, through American students — Cross, Iddings, Diller, Adams, Williams and others—returning from the laboratories of Zinkel or Rosenbusch. Subsequent detailed study has made it possible to say that we have about completed our knowledge as to components and structures of rocks. Petrography has become petrology, and we are now looking forward to a greater understanding of processes.

Another important subject gaining in attention in the last three decades relates to the after-effects of igneous intrusion.

No matter how undisturbed are sedimentary strata, it is never safe to assume that igneous rocks may not be associated. The basic dikes of western New York, Kentucky, and Arkansas are examples. The flat beds around the Gulf of Mexico are penetrated by basaltic plugs near Tampico, and even the salt domes of Texas and Louisiana persistently suggest underlying intrusive masses.

We now know more about the chemical components of the igneous rocks than of the igneous magma. Magmas contain dissolved gases, most of which escape on crystallization. Experience assures us that, in general, high silica magmas are richest in these gases, and basic ones less so. These gases are almost universally held to be as much a part of the deep-seated magmas as are the silica and the common bases. On cooling, most of these gases escape, although small amounts remain in the composition of certain minerals; and they doubtless separate as the rock crystallizes.

The effect of these gases is observed in the intrusive rock itself in minerals developed after the main crystallization. Orbicular or spheroidal granites or diorites may be due to this stage and class of igneous phenomena, and inclusions in ingneous rocks may be perfectly altered by the same agencies.

What do we know as to the actual composition of these emitted gases? At Kilauea, Day and Shepard caught from the basaltic magma, water, carbon dioxide, nitrogen, carbon monoxide, and sulphur trioxide—also soda, potash, lime, ferric oxide, and alumina, but no silica. At Katmai, Allen and Zeiss have found, in the emanations, water, carbon dioxide, nitrogen, hydrogen, sulphide and hydrogen, methane and oxygen. Indicated compounds are hydrochloric acid, hydrofluoric acid and hydrogen sulphide. A computation of fifty analyses of volcanic emissions by F. C. Lincoln has indicated that after water-gas, carbon dioxide is the most abundant. Then comes nitrogen; then hydrofien sulphide; then sulphur dioxide; then hydrochloric acid, hydrogen, and methane. Among the condensible components come sulphur, salt, salammoniac, and ferric chloride; in small quantities, tellurium, arsenical compounds, boric acid, and all the common economic metals except gold and silver. Silica is missing, although it occurs in hot spring waters and is most characteristic of contact zones and mineral veins.

Volcanic emissions are only a partial indication of what takes place around a deep-seated intrusion under high pressure and temperature, and under the precipitative influences of the wall rocks. One of the most indicative things is the impregnated ancient strata in the Pre-Cambrian ancient gneisses of sedimentary origin which have been soaked with the juices of igneous rocks. Around igneous intrusions the alteration has in many cases been so profound that it is difficult to determine where original sedimentary matter ends and contribution from the intrusions begins; and near the intrusion, the alteration may be so intense as to cause the altered rock to be mistaken for igneous. The partial bed-by-bed (lit-par-lit) alteration of sedimentaries is closely allied to the phenomena of contact zones; where shales are crystallized into new minerals; and with limestones where characteristic lime silicates are developed. The early view of these lime silicates was that they represented the crystallization of material already in a limestone, but in 1905 Kemp and Lindgren announced that the garnet of these contact zones, instead of being of the lime-alumina variety, was the lime-iron variety (andradite), demonstrating the introduction of some iron into the limestone at the time of crystallization. There are also, besides the iron silicates and oxides (magnetite and specular hematite) great bodies of iron sulphides, sometimes with copper and other ores associated. Clearly, also, silica has been introduced. The general order of introduction seems to be: first, lime silicates; second, iron oxides, magnetite, and specularite; third, sulphides of iron, copper, and other metals.

As to the mineral veins, the significance of the mineral-bearing pegmatites has been realized more and more, as they have been found to be sources of tungsten, molybdenum, and other ores. This realization of their significance to the study of ore deposits began in the early 90's; and the study was led by Vogt in Norway, and the distinctive American school, presented by the writings of Lindgren, Spurr, and Kemp, emphasizing more and more the growing faith in the explanation of ore deposition as an after-effect of igneous intrusion. In 1901 Kemp pointed out the absence of meteoric waters in deep mines, and the estimate of Delesse in 1861 that the total amount of the

*An abstract.

ground waters would yield a layer 7,500 ft. deep uniformly over the earth has been gradually reduced to that of Fuller in 1906 of only 96 ft.

In 1906 Lindgren gave his noteworthy address on "The Relation of Ore Deposits to Physical Conditions," and in 1907 Spurr published his valuable contribution, "A Theory of Ore Deposition," in which he outlines the zonal theory of ore deposition in successive zones or stages, away from a central magmatic source, the different zones being marked by characteristic metals. This sequence has been corroborated in whole or in part by many observers.

My conclusion is that, in spite of my early training, I have been irresistibly drawn by study and logic to a confidence in the great part played by igneous forces in nature. We have now learned many facts concerning them, and we are now in process of interpreting them. The intrusive rocks and their emissions constitute an explanation of recrystallization of ancient strata of contact zones, pegmatites, and quartz veins and of the zonal distribution of ores.

In the future, we hope to find out the causes of upward intrusion; why igneous magmas differentiate; and why the differentiated products resume their upward journey.

MEN YOU SHOULD KNOW ABOUT

Morgan H. Wright was recently in New York.

W. A. Funk has gone to Los Angeles on professional business.

Eugene Dawson will go to Panama on mining business, to be gone about thirty days.

Richard A. Parker, of Denver, and **Mrs. Parker** left New York this week for Italy.

R. V. Whetsel is in New York, and will return to Tampico, Mexico, in a few days.

Walter Douglas, president of the Phelps Dodge Corporation, is on an inspection trip in Arizona.

William B. McKinlay is now at Quiruvilca, Peru, with the Northern Peru Mining & Smelting Co.

Gerald H. Hutton, of the Gold Canyon Dredging Co., has recently returned from Dayton to San Francisco.

R. H. Elliot, vice-president of the United Comstock Mines Co., is in Gold Hill on professional business.

A. J. Clark, metallurgist of the Homestake Mining Co., is in New York, his father having recently died there.

Bernard MacDonald has returned to Parral from an examination of mines at Indé, in the State of Durango, Mexico.

Nathaniel L. Amster, Boston mining man, with his family, is spending the last of the colder months in Phoenix, Ariz.

J. A. Cullen has been assigned to cement experiment work at the Columbus station of the U. S. Bureau of Mines.

Charles Dunphy and **H. R. Bostick,** of San Francisco, were recent visitors to the San Dimas mine, in Durango, Mexico.

N. M. Getchell, manager of the Betty O'Neal mine near Battle Mountain, has returned to Battle Mountain from Salt Lake City.

W. Haseltyne has been placed in charge of the concentrating and cyanide plants at the Premier mine, Portland Canal.

P. G. Beckett, general manager of the western operations of the Phelps Dodge Corporation, has reopened his offices at Douglas, Ariz.

Samuel H. Bolbear will spend most of the next two or three months in Canada. He was a recent visitor at the Vimy Ridge mine, Coleraine, P. Q.

Colonel C. H. Machin, of Kenora, Ontario, is in New York completing financial arrangements for the opening of the Mikado mine, in the Lake of the Woods district.

Charles F. Mason sailed on the "Huron," Feb. 18 for Argentina, where he will supervise the installation of Holbeck powdered-coal equipment at the Famatina smelter.

M. M. Blazquez and **J. W. Barry,** directors of the Cia. Minera la Constancia, have returned to Saltillo from inspection of the properties of the company in Sierra Mojada.

H. G. Thiele, formerly with the Oliver Continuous Filter Co., is now connected with the Engineering Structures Co., Call Building, San Francisco, specializing on structural erection.

Patrick Daly, veteran prospector and mine operator of Stewart, B. C., has left for New York to interest capital in mining properties of the Salmon Arm section of Portland Canal district.

Bulkeley Wells, president of the Metals Exploration Co., en route to San Francisco from New York, stopped off at Virginia City, Nev., on Feb. 7 to inspect operations at Gold Hill and Gold Canyon.

Norman Carmichael, former general manager for the Arizona Copper Co., Ltd., is in Phoenix, Ariz., with **Mrs. Carmichael,** for a period of rest and recreation before starting for New York, where they will make their home.

Senator Samuel D. Nicholson, member of the Senate Committee on Mines and Mining, was in Denver during the week of Feb. 13, conferring with Colorado mining men concerning measures pending in Congress affecting the mining industry.

Dr. F. V. Meriweather, of the U. S. Bureau of Mines, has been assigned to the Houghton station for temporary duty. Dr. Meriweather was chief physician for the Public Health Service at the Muscle Shoals plant and also saw service overseas.

D. M. Drumheller, Jr., formerly manager of the Tidewater Copper Co., has returned to Sidney Inlet, where he will supervise the reopening of the company's Indian Chief mine and plant. Mr. Drumheller has been in private practice in Spokane for a year.

H. A. Doerner has been assigned to rare-metal work at the Reno experiment station of the U. S. Bureau of Mines. Mr. Doerner was formerly connected with the Denver office of the Bureau of Mines. For the past several years he has been engaged in commercial work.

John C. Creenway, general manager of the Calumet & Arizona, has been commissioned a brigadier general in the United States Reserve Corps, assigned to command of the 409th and 410th infantry regiments, within the 103d Reserve Division, which embraces Colorado, Oklahoma, New Mexico, and Arizona.

SOCIETY MEETINGS ANNOUNCED

Engineers' Club of Northern Minnesota will hold its annual banquet at Hibbing, Minn., on the evening of Feb. 25. The principal speaker of the evening will be John Stone Pardee, who will address the club on the subject of the Great Lakes-St. Lawrence deep-waterway canal.

OBITUARY

John Adams Smith died in Montreal on Feb. 11 after a long illness. Mr. Smith was one of the pioneers of the Rossland, B. C., and Porcupine mining districts.

John F. Shafroth, former United States Senator from Colorado and twice Governor of the state, died at Denver on Feb. 20 after a week's illness. He was sixty-seven years old. Senator Shafroth was one of the original commissioners appointed by President Wilson on the War Minerals Relief Commission.

Lucien H. Norton, of the firm of Root & Norton, Durango, Col., died on Feb. 10 of heart failure. Mr. Norton was a graduate of the Columbia School of Mines, class of 1886. After his graduation he was employed by an English mining company in San Domingo. Later he became identified with the Pennsylvania Lead Co. at the smelter at Sandy, outside of Salt Lake City, and then removed to Park City, where he was employed at the Mercur mine, at the time of one of the first trials of the cyanide process in this country. In 1895 he removed to Monterey, Mexico, where he was chief assayer, for the Guggenheim smelter there, for five years. From 1900 to 1902 he was superintendent of the Humphreys M. & M. Co. at Creede, Col. In 1908 the partnership of Root & Norton was formed.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Leading Events

A strike in the Tintic district, Utah, caused by the recent reduction in wages there, has resulted in the old wage scale being restored in that camp.

Reduction of freight rates has virtually been asked of the Interstate Commerce Commission by the directors of the Colorado Metal Mining Fund and the Colorado Metal Mining Association.

The Lone Pine-Surprise Consolidated Mining Co. has won the decision in the apex suit brought against it by the Day interests. The finding of the lower court has been affirmed.

Inspiration Consolidated has put four units of its mill in operation. False reports of a labor shortage have caused many to go to the Globe-Miami district seeking employment. United Verde Extension has started one reverberatory.

The Daly West Mining Co., at Park City, Utah, is to be taken over by a new company headed by George W. Lambourne. The Judge holdings may be transferred to the same company, it is said.

War mineral relief claimants to the number of 837 have asked rehearing of their cases.

Inspiration Starts Four Units of Concentrator

False Reports of Labor Shortage Cause Flood of Men Seeking Employment in District

Inspiration has resumed production of concentrates with four of the twenty units of its mill, after nine months' idleness. Half of the mill is ready for operation at any time. The company is reported to have struck a large body of 2 per cent mixed carbonate and sulphide ore in the new Porphyry shaft, which has gone through about 60 ft. of mineralized material without striking bottom. The shaft is now about 420 ft. deep, and is being pushed at the rate of 7 or 8 ft. a day. The same orebody was cut several years ago in the old Barney shaft, 200 yd. distant and at about the same depth. The shaft is to have modern and expensive equipment.

The International smelter is operating two reverberatories at capacity. No. 1 furnace is not expected to be ready for operation before March 15, when Old Dominion concentrates are expected. Inspiration concentrates are to be handled at Miami and a corresponding cut made in the amount of Miami concentrates. The two furnaces will continue their normal output of about 15,000,000 lb. of blister copper per month. When the smelter closed last May, there was on hand 65,000,000 lb. of copper bullion, now reduced to 10,000,000.

Old Dominion is expected to start operation about March 1 and to be operating its mill within a few days thereafter. H. C. Plummer, general manager of the Arizona Commercial, states that his company will resume shipments of ore as soon as the Old Dominion mill is ready, about March 1. He has added to his underground force and has started operation of the power house.

Iron Cap is operating its mill two shifts at about two-thirds capacity and is sending concentrates to the International smelter.

Both Globe and Miami are flooded with new arrivals of men seeking employment, brought here by erroneous reports of a labor shortage. Skilled labor will be recruited from former employees. Of unskilled labor there is a surplus already.

A material reduction has been made on ore shipments from the district to El Paso, with a base of $2.60 a ton in car-load lots on ores valued at $15 a ton, ranging up to $7.37½ on $150 ore. The old rate started at $3.38 for $15 ore. Almost all the ores shipped are valued between $15 and $30 a ton.

Strike at Mount Morgan Settled

By Cable From Reuters to "Engineering and Mining Journal"

Brisbane, Feb. 16—The strike which, owing to a reduction in wages, has been in effect at the Mount Morgan Gold Mining Co.'s property has been settled. It is expected that work will be resumed in about three weeks.

Lone Pine-Surprise Wins Apex Decision

The Circuit Court of Appeals has confirmed Judge Rudkin's decision in favor of the Lone Pine-Surprise Consolidated Mining Co., owner of the Last Chance Gold Mine, at Republic, Wash. This company several years ago was made defendent in apex litigation brought by Republic mines branch of the Northport Smelting & Refining Co., owners of an adjacent mine. The plaintiff sought about half the ore above the 500 level of the Last Chance mine and nearly all below it; also damages totaling about $100,000 for ore removed by the Last Chance. Judgment for the Lone Pine company was entered in the Federal Court at Spokane during 1920. The decision was appealed, only to be confirmed as stated.

Colorado Operators Seek Freight Reduction

Interstate Commerce Commission Petitioned by Directors of Two Organizations

Reduction of freight rates has been asked by the board of directors of the Colorado Metal Mining Fund and the Colorado Metal Mining Association, on behalf of the ore producers of the state. A statement has been filed with the Interstate Commerce Commission, asking that, in the proceedings now pending before the commission, special notice be taken of the deplorable condition of the metal-mining industry in Colorado, so that such remedies as are possible may be applied.

The statement recites conditions in Colorado in support of the following recommendations:

A uniform reduction of freight rates on ores and concentrates throughout Colorado to the basis of the rates in force prior to May, 1918.

A revision of freight rates on coal and coke from the producing points to metal mines and smelters.

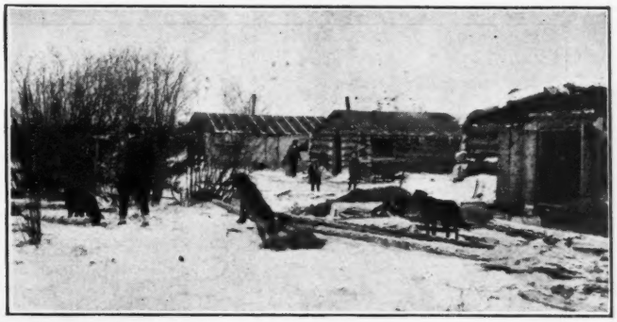
A modification of the rates on lead bullion and copper matte from Colorado common points to the Atlantic seaboard to a parity with those in force prior to 1918.

Spain Revises Export Duties

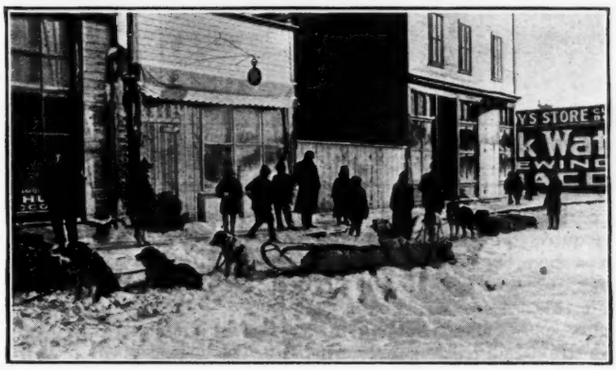
By Cable From Reuters to "Engineering and Mining Journal"

Madrid, Feb. 16—The new tariff which became effective today fixes the following export duties: Pyrites, .15 pesetas per ton; other iron ores, .20 pesetas per ton; copper ores, .15 to 10 pesetas per ton, according to richness; copper precipitate, 35 pesetas per ton; wolfram, 25 pesetas per ton; manganese, .20 to 1.50 pesetas per ton; and lead ores, a rate of 20 pesetas per ton export duty.

CROSSING ELBOW LAKE, NORTHERN MANITOBA



CAMP ALONG TRAIL TO ELBOW LAKE



IN THE PAS, THE "JUMPING OFF PLACE" FOR NORTHERN MANITOBA.

The Elbow Lake Strike—Another Porcupine?

Three Big Companies Already Interested in Manitoba's Newest Gold District—Spring Rush Expected—Mineralization Suggests Possibilities of Opening Large Mine

By WALTER A. RUKEYSER
Written for *Engineering and Mining Journal*

LATE LAST SUMMER two brothers, Gordon and Kenneth Murray, made a spectacular gold discovery at Elbow Lake, about 125 miles by trail north of The Pas, Manitoba. An option on this group of five claims was taken by S. W. Cohen, of Montreal, who immediately made a thorough examination of the property. In October this option was taken up by the Hollinger interests through the agency of Mr. Cohen. Since that time there has been an ever-increasing impetus to a healthy development of the new district and a veritable rush of prospectors, brokers and engineers into the country.

Elbow Lake lies in the east-central part of an intensively mineralized zone extending from the already famous Flin Flon and Mandy copper properties on the west to Herb Lake, with its small but consistent veins of high gold content, on the east. This zone, approximately 100 miles in an easterly and westerly direction by 30 miles north and south, consists of a series of basic volcanic flows now altered to greenstones and chlorite schists. These have been intruded by large batholiths of granite and a series of related acidic dikes, quartz porphyries, syenites, and the like. All these formations are of pre-Cambrian age.

The spectacular showing uncovered by the Murrays lies in the greenstone at or near the contact with the granite mass. The work done to date consists of a series of deep trenches crosscutting the formation for well over 100 ft. and at intervals along the strike for 500 ft. or more. The greenstone apparently was sheared before or at the same time that the intrusion of the granite and acid rocks took place. It is replaced in varying degree by the action of highly siliceous solutions and has been mineralized with quartz, free gold, pyrite, and other iron sulphides. It is a peculiar characteristic that practically all of the pyrite is in the residual greenstone, whereas all the free gold that I observed, at least, is included by the quartz. This occurs in the form of veinlets, flat seams, and irregular masses throughout the mineralized zone.

It has been said by authorities on the district that the mineralization is genetically related to the granite. However, my own impressions (they cannot be called more than that) are that sufficient emphasis has not been placed on the porphyritic and associated dikes as a factor in the mineralization of the greenstone.

The gold occurs as nuggets and large spatterings of a most spectacular nature, and it has furthermore been proved that, disregarding these visible showings, the intermediate rock assays high across the widths developed by the trenches. Furthermore, these remarkable showings extend over a wide area, and shots which have been placed in rock under the muskeg nearly 3,000 ft. north of the original discovery have brought to light similar extraordinary results. One more fact that leads to the belief that this is in reality a mineralized zone, and not a vein or shoot in any sense of the word, is that one can blow out a spectacular showing, go down a few inches without encountering visible gold, and then suddenly again encounter a large display.

The Hollinger representatives have just completed cutting a forty-five-mile winter road from Mile 55 of the Hudson Bay Railway. This, it may be remembered, was put through from The Pas to Fort Norman, on Hudson Bay, for the purpose of supplying a short haul to the sea as an outlet for western Canada's grain. The project, started in Premier Laurier's administration, has never been completed, although steel has been laid for 211 miles. A mixed train is operated fortnightly over the line.

At the instigation of Philip L. Foster, representing English interests, I have just made the trip to Elbow Lake. George Bancroft, who was with J. E. Spurr's party when the Mandy was located, accompanied me from The Pas and also acquired property for his interests. Travel was by dog team and the longer trail (about 125 miles), following the waterways, was taken, as we could not be dependent upon the bi-weekly train service to Mile 55. By easy stages it took three and one-half days each way to make the trip.

Hundreds of claims had been staked; in fact, as far south as Island Lake, north to the head of Elbow and east to Claw, the country had been blanketed, most of the locations having been made over the snow. A large number of

CAMP OF HOLLINGER CONSOLIDATED GOLD MINES, LTD., AT ELBOW LAKE

claims have already changed hands; syndicates have been formed to acquire property, and even some small companies organized in anticipation of the boom which is bound to result this spring. Already there is an influx of prospectors from the more beaten trails of Ontario. The usual amount of wildcatting is prevalent.

On the whole, however, the prospects for an intelligent development by responsible interests are bright for this new district, hitherto neglected even by prospectors, probably a natural sequence to war and post-war conditions and a general lack of available capital. The Hollinger, I am told, will have a force of nearly sixty men on surface development this spring. At present its group of thirty-five men are completing camps, bunkhouse, grubhouse, stable, office, assay hut, and powder house. The work will be pushed energetically by their engineer in charge, Mr. Rutherford, and his foreman, Mr. Dowley.

WALTER A. RUKEYSER

The Tonopah interests will undoubtedly be represented by George Bancroft, and I am at present preparing to return to the district to take charge of a quite extensive development program. Work will be done on not only the gold properties at Elbow Lake, but also on some promising copper options which have been acquired on the zone west of this immediate locality.

It is an interesting fact in connection with the foregoing that the Mining Corporation of Canada, which now controls the Flin Flon, has had substantial assurance from the Manitoba provincial government that a railroad will be built into the district as soon as large-scale development begins. This would run about thirty-five miles south of Elbow Lake, and if the present interviews of Mr. Brigham, general manager of the Hollinger company, with the representatives of the government are successful, one can rest assured that should later conditions warrant, Elbow Lake will not lack adequate rail transportation. The same applies to the power situation, for large water power is available for development within easy transmission radius of the entire mineralized belt.

Preliminary geological reports have been prepared by Professor Wallace, of the University of Manitoba, and E. L. Bruce, of the Canadian Geological Survey. These, with accompanying maps, can be obtained from J. O. Campbell, the Commissioner for Northern Manitoba at The Pas.

Copper Radiator Being Tested By New Cornelia

Tests are being conducted with an automobile radiator of copper by the New Cornelia Copper Co., at Ajo, Ariz. The work began more than a year ago, and improvements have been made from time to time. The cooling ability of the copper radiator has already been proved.

Wages Raised Following Strike in Tintic District, Utah

The Walkout on Feb. 15 Results in a Restoration of Scale Effective Before Reduction Was Made

Because of the reduction in wages of 50c. a shift on Jan. 16 in the Bingham Canyon and Tintic districts, Utah, with no reduction at Park City, the miners at the Eagle & Blue Bell and the Victoria mines, in the Tintic district, walked out on Feb. 11 for a 50c. increase in wages—that is, for the former wage scale in effect prior to Jan. 16. The Tintic Standard company was affected to a lesser extent, in that about 20 per cent of its men walked out, the others deferring action until their petition for a 50c. increase in wages with a reduction of 30 per cent in board charges was considered by the Tintic Standard management.

On Feb. 15 the Tintic Standard announced an increase in wages of 50c. a shift, as did also the Eagle & Blue Bell and the Victoria. The men at these properties returned to work. This increase made by the Tintic Standard and Eagle & Blue Bell necessitated a 50c. increase in wages by other Tintic mines, so that machine men now receive $4.25 per shift, instead of $3.75, which was in effect for about a month.

Properties whose operations are carried on largely by lessees—for example, the Chief Consolidated, Gemini, Ridge & Valley, Grand Central, and others—were affected to a lesser extent than some of the others, as there are a relatively smaller number of company employees. Whether Bingham will make a 50c. increase or not has not been determined to date.

Lambourne Heads New Company at Park City, Utah

Announcement has been made of the formation and financing of the Park City Mining & Smelting Co., of Park City, Utah, incorporated under the laws of Colorado, with an authorized capital of $7,500,000, divided into 1,500,000 shares of $5 each. Officers are G. W. Lambourne, president and managing director; Moylan C. Fox, vice-president; O. N. Friendly, manager; George S. Kruger, superintendent of mines; and D. C. Murphy, secretary. The Daly-West Mining Co., of Park City, Utah, will be taken over in exchange for treasury stock as soon as details can be arranged. This was authorized unanimously by Daly-West stockholders at a special meeting held in Denver recently. The stock in the Daly-West will be exchanged for 250,000 shares of Park City Mining & Smelting Co.'s stock on the basis of share for share in the Daly-West. The Judge Mining & Smelting Co. will be invited in the near future to transfer the property of that company to the Park City Mining & Smelting Co. upon an equitable basis. Other properties may be acquired.

NEWS FROM WASHINGTON

By PAUL WOOTON
Special Correspondent

5,000 Companies Show Income of 10 to 16 Per Cent in 1919

Net Return on Invested Capital of 1,091 Gas and Oil Operators, 12.45 Per Cent

Companies engaged in mining and quarrying to the number of 4,708 that reported invested capital to the Bureau of Internal Revenue for 1919 had an income amounting to 10.15 per cent of that capital; 373 metal-mining companies show a net income of 16.26 per cent on invested capital; 1,091 gas and oil companies show a net income of 12.45 per cent on their invested capital. The Bureau of Internal Revenue of the Treasury Department on Feb. 20 released for publication a statistical compilation, just completed by the Bureau, of the income taxes paid by industries in 1919.

Altogether, 18,469 companies engaged in mining and quarrying made returns. Of this number, 13,197 reported no net income whatever. The detail of the compilation covering mining and quarrying is shown in the table.

CORPORATION RETURNS—DISTRIBUTION BY INDUSTRIES FOR THE UNITED STATES

Income Returned for the Calendar Year Ended Dec. 31, 1919

Industries	Total Number of Corporations	Corporations Reporting Net Income: Number	Net Income	Income Tax	War Profits and Excess Profits Tax	Total Tax	Corporations Reporting No Net Income: Number	Deficit
I. Mining:								
Coal mining	3,288	1,581	$99,142,382	$8,402,818	$9,298,252	$17,701,070	1,647	$23,748,807
Metal mining—								
Iron	119	47	3,829,527	325,442	292,362	617,804	72	1,444,307
Copper	241	29	10,490,792	916,619	7,226	923,845	212	10,051,758
Lead and zinc	192	35	9,502,566	833,879	162,962	1,046,841	157	2,695,184
Gold, silver and precious metals	516	122	5,195,635	478,786	101,278	580,064	394	10,829,985
All other mining	2,489	263	44,053,032	3,931,764	2,146,457	6,078,221	2,226	23,489,858
Non-metal mining:								
Oil	2,820	1,098	194,028,005	17,032,714	20,868,157	37,900,871	1,722	41,004,128
Gas	179	117	4,359,090	386,095	348,708	734,803	62	265,050
Salt, mines and other sources	40	23	3,968,041	354,105	361,204	715,309	17	266,962
All other non-metal mining	3,499	779	36,605,129	3,217,282	2,192,678	5,409,960	2,720	19,217,803
All other mining concerns, combinations and tributary industries	3,969	576	10,687,024	946,820	460,836	1,407,656	3,393	43,761,510
Total mining	17,292	4,670	$421,861,223	$36,876,324	$36,240,120	$73,116,444	12,622	$176,775,352
II. Quarrying:								
Stone	290	166	3,478,089	284,967	323,110	608,077	124	785,966
Clay, sand and gravel	538	295	3,466,992	268,406	298,146	566,552	243	1,410,730
Precious and semi-precious	17	13	1,499,263	116,339	307,079	423,418	4	6,689
All other quarrying	235	93	2,008,190	167,289	172,432	339,721	142	1,415,727
Total quarrying	1,080	567	$10,452,534	$837,001	$1,100,767	$1,937,768	513	$3,619,112
Mining and quarrying combinations, but main business not given	97	35	309,944	24,691	2,609	27,300	62	559,205
Grand total mining and quarrying	18,469	5,272	$432,623,701	$37,738,016	$37,343,496	$75,081,512	13,197	$180,953,669

Appropriations Bill Passed

The House has passed the Interior Department Appropriation bill with appropriations for the U. S. Bureau of Mines and the U. S. Geological Survey as recommended by the committee. A motion of Representative Carter, of Oklahoma, to abolish the offices of Surveyor General of Colorado, Oregon, Washington and Wyoming was defeated.

Appropriations for the mint and assay service for the year beginning July 1 are authorized in the Treasury Department appropriation bill, which has been approved by the President.

Product of Ore Treatment Not an Ore

A product resulting from a number of processes applied to an ore is not to be classed as an ore, according to a decision that has been handed down by the United States Court of Customs Appeals in the case of Tower & Sons *vs.* the United States. The question arose over an importation which was assessed by the collector of customs as oxide of cobalt. The importer contended that it should be admitted free as "cobalt and cobalt ore." The importation was in the form of a heavy grayish black powder. It was admitted that the product was a residuum remaining after the natural ore had been subjected to various treatments. The ore had been roasted, it was testified, to eliminate the arsenic. It then had been treated with an acid to concentrate its soluble components. A part of the residuum was precipitated, filtered, dried, and ground. The court held that, after these treatments, the product could not be classed as an ore. Incidentally, the testimony developed that it could not be classed as oxide of cobalt, as the analysis disclosed that it contained 28 per cent of oxide of nickel.

Blue-Sky Bill Hearings Over

Hearings on the Denison blue-sky bill closed before the House Interstate Commerce Committee recently, those appearing in favor of the legislation including Franklin Leonard, representing the New York curb market; G. S. Canright, of Madison, Wis., representing the association of securities commissioners; Roy C. Osgood, a Chicago banker, and George W. Hodges, of New York, representing investment bankers.

837 War Mineral Claimants Ask Rehearing

Quarter Million Award Recommended for Whitmarsh Mining Co.—Crosby Claim Considered

Formal application has been made under the amended War Minerals Relief Act for a rehearing of 837 claims. In numerous cases efforts to locate claimants failed, and for that reason they received no official notification of the change in their status. It was possible to locate only thirty-five of the fifty-one claimants whose cases had not been considered, on account of the fact that their original applications for relief were received too late.

The commission has recommended an award of $226,348.66 in the manganese claim of the Whitmarsh Mining Co. The company claimed net losses of $325,268.77. A recommendation for the payment of $22,517.77 was made in the companion claim of George H. Crosby. The original amount claimed in this latter case was $60,549.51.

Finance Committee Silent on Tariff Bill

Zinc, manganese, graphite, and mica are to be on the free list when the tariff bill emerges from the Finance Committee, it is stated on good authority. The members of the Finance Committee are making no announcements. They decline to confirm or deny the various rumors as to decisions the committee is said to have made. As any decision made in committee is subject to revision, it is difficult to ascertain with certainty what any schedule may be when the bill is finally reported to the Senate.

NEWS BY MINING DISTRICTS

London Letter

Globe & Phoenix Company's Ore Reserves—Gaika Gold's Policy Reversed—Esperanza Again Active

BY W. A. DOMAN

London, Feb. 7—Certain persons interested in the Globe & Phoenix Gold Mining Co. are becoming uneasy at the condition of the ore reserves. At the end of December the grade showed its first big drop for many years, being about 5 dwt. less than previously reported. As I have mentioned on a previous occasion, the ore reserves are now divided into "available" and "pillars," and the latest estimate of the "available" is that the grade is down nearly 8 dwt. Its tonnage is equal to about ten months' mill supply at the current rate. The ore in pillars cannot well be used until the mine is finished, and as it has to be removed slowly, say at the rate of about 2,500 tons monthly, it is probable that costs will be high and profits small. The loss in recovery may be regarded as about 5 per cent., and with gold at its present price—and the "premium" is running off—there will not be much surplus for dividends after the working costs, depreciation, and taxes have been met. Since the reserves were separated into "available" and "pillars," the figures have been as follows:—

	Tons	Contents, Ounces	Value, Dwt.
December, 1919			
Available ..	62,941	97,475	30.97
Pillars	45,241	78,216	34.58
December, 1920			
Available ..	47,380	62,753	26.49
Pillars	46,472	82,568	35.53
December, 1921			
Available ..	62,000	58,300	18.81
Pillars	48,000	81,800	34.08

The Gaika Gold Mining Co., another Rhodesian, is also in an interesting condition. The new directors are endeavoring to make their influence felt both financially and in a technical sense, and to a certain extent are reversing the policy of their predecessors. The latter had retained a large sum from profits and had invested it mainly in government securities upon which depreciation had left its mark. The financial resources amount to about £70,000, or about 50 per cent of the market price of Gaika shares. The new board is investing a portion of this in Rand mining and other shares such as New Modderfontein, Geduld, Springs Mines, Brakpan, and Union Corporation. The idea seems to be to earn a larger income. Several big shareholders are protesting, saying they would prefer to do their own speculation. The new chairman is of the opinion that the shares mentioned are not speculations but mining investments. The ore reserves at the end of the past three quarters compare thus:

June 30, 73,000 tons, valued at 13.2 dwt.

Sept. 30, 68,000 tons, valued at 13.0 dwt.

Dec. 31, 64,000 tons valued at 13.0 dwt.

The Gaika mine is an erratic property, and an extensive development program is to be undertaken.

After a period of quietness, the Esperanza is coming into the limelight again. For two consecutive weeks encouraging development cable dispatches have come to hand concerning the Descubridora vein, on the 5th level, north drift. For the week ended Feb. 2, the advance was 12 ft., the average width of the vein being 16 in. and the assay values 2.78 oz. gold and 52.53 oz. silver. This follows upon an advance of 24 ft. showing an average width of vein of 20.48 in., with assays of 2.68 oz. gold and 58.31 oz. silver. Winze No. 12 is fairly encouraging. The first 10 ft. of sinking disclosed the vein 15 in. wide assaying 0.91 oz. gold and 26.23 oz. silver; the next 30 ft. gave an average width of 26 in., and the gold content had improved to 2.16 oz. gold, and 27.70 oz. silver.

Freight Rate Cut Because of Water Competition

During a discussion of ore rates before the House Appropriations Committee, Representative Newton, of Minnesota, said, in advocating a $40,000,000 appropriation for improvement of the Mississippi and Ohio rivers: "The rate on iron ore from Minneapolis to St. Louis is 25½c. per 100 lb., carload lots. There is a shorter haul and better railroad facilities from Minneapolis to Kansas City than from Minneapolis to St. Louis, but there is no water route. The rate is 34c. from Minneapolis to Kansas City. That is done in order to cut under the Goltra Line. There is the difference between 25c. and 34c., the lower rate being on a railroad that winds along with the river for a long distance as against a higher rate for a shorter haul across the prairie to Kansas City."

Would Give Unreserved Lands to States

A bill ceding to the states the unreserved public lands remaining in them, and providing that the revenue from disposition of the land shall be divided into four parts, has been introduced in the Senate by Senator Bursum, of New Mexico. One fourth of the revenue is to be allotted to educational purposes, including schools of mines; a fourth to public roads; and a fourth each to public schools and to irrigation.

Johannesburg Letter

December Gold Output of Transvaal Drops—Decimal Coinage Proposed

BY JOHN WATSON

Johannesburg, Jan. 17—The gold output of the Transvaal mines for December was announced on Jan. 10 as 681,847 oz. of fine gold, which is a decrease of 22,389 oz. compared with the previous month. The greatest decrease, taking individual mines, was that of the Crown Mines, where a decline of 11,450 oz. was recorded, this being due of course to the strike which prevailed at that mine up to Dec. 5. The Ferreira Deep had a drop of 3,254 oz. compared with November, due to the underground fire and fall of rock, already reported. The price of gold for December has been calculated at £4 15s. 6d. per fine ounce, as against £5 10s. for September. Owing to the fall in the price of gold and the above noted causes, the decrease in value of the December output was equal to £335,784. For the year 1921, the total gold output of the Transvaal was 8,114,586 fine ounces, having a value of £42,017,350. This is a decrease in weight of 39,586 oz., and in value of £1,090,734, compared with the year 1920.

The decimal system of coinage may soon be adopted in the Union of South Africa. At a joint meeting of the scientific and technical societies held in Johannesburg some years ago, the majority of members were in favor of this system. We now learn that it is understood that during the ensuing parliamentary session, the government will introduce a bill to establish the decimal coinage system. A sovereign now represents 240 pennies, or 960 farthings. In the new system the sovereign will represent 1,000 farthings (or cents). The florin or 2s. piece will be continued; but the half-crown will disappear. A florin will be worth 100 cents and will be divided into a half-florin (50 cents) and a quarter-florin (25 cents), roughly representing our present shilling and sixpence. This secures the decimal system, with little deviation from the present. Instead of silver "tickeys" (threepennies) there will be nickel coins worth 10 and 5 cents. These will, of course, differ slightly from our pennies and half-pennies, as 1,000 cents will equal in value 960 farthings.

The unfortunate strike still continues, both at the collieries of the Transvaal and at the gold mines of the Witwatersrand. A conference is being held daily, to discuss the possibilities of a settlement. It is estimated that the direct and indirect loss daily sustained by workers and the community during the first week of the strike will be as

follows: Employees' loss of wages, £35,000 per day; employers' direct loss, standing charges and natives' expenses for first week, £35,000 per day; community's direct loss, amount expended by mines in wages, stores, and fixed charges, £9,000 per day. If the strike continues after the first week the direct loss to the employers will be reduced by reason of the repatriation of many of the time-expired natives.

CANADA

British Columbia

Premier Acquires Control of B. C. Silver Mines, Ltd.—Cork Province Mine To Improve Power Plant

Stewart—Particulars have been published of negotiations under the terms of which the Premier Mining Co. acquires control of the holdings of the B. C. Silver Mines, Ltd. These consist of seventeen Crown-granted claims and fractions adjoining the Premier company's property. The Premier has obtained over half a million shares of the B. C. Silver Mines, paying more than $100,000 for them. The British Canadian Silver Corporation, Ltd., a British company, controls the issued stock of the B. C. Silver Mines, Ltd., and has an option on all the treasury stock, for which the consideration was 800,000 fully paid-up shares in the British Canadian Silver Corporation. The latter corporation is capitalized at £400,000 sterling in 5s. shares, of which 1,000,007 shares are issued and fully paid up. The company's head office is at 19 St. Swithin's Lane, London, England. The British Columbia offices of the company are in the Pacific Building, Victoria.

The aërial tramway to the Silverado group, on Portland Canal, is ready for operation. A snow trail has been constructed from the lower terminal to tidewater. With these facilities considerable high-grade ore, now ready, will be shipped. Plans are being made fore next season's development work.

A permanent bridge is to be constructed by the Provincial Department of Mines across the Bear River, replacing that which was washed out by recent floods. This will assure ready access to the mineral properties of the upper Bear River and its tributaries.

Alice Arm—The Lion Group of claims, situated near the town of Alice Arm, has been found to carry several small veins of high-grade ore, which were uncovered in crosscutting at a distance of 100 ft. from the surface. One hundred tons of high-grade ore taken from the Esperanza mine is ready for shipment.

Kaslo—Improvements are to be made to the power plant of the Cork-Province mine, to permit the mine and mill to be operated throughout the year. No work was done last year.

On the Bell group, Wallace Mountain, a promising vein of ore has been uncovered. A shipment is being prepared for the Trail Smelter.

Quesnel—Placer ground on Cedar Creek, which was found to contain good values last summer, has been bonded to outside interests, the intention being, it is stated, to undertake development during this year's open season. The Del Ecuador Mining Co., Ltd., has also acquired holdings in the same locality, and is reported to be arranging to put a dredge to work as soon as weather permits. Hydraulicking is to be undertaken soon by the Cariboo Goldfields, Ltd., on Roses Gulch.

Rossland—Operation of Le Roi No. 2 (Josie) mill has been suspended because of cold weather. Word has been received from Ottawa that the Railway Commission has no jurisdiction over the Great Northern branch line extending from Rossland to Northport, Wash., nor any part of it. A successful conclusion of the efforts now being made by local interests to prevent abandonment of the branch line, at one time noted for its heavy ore traffic, appears to be remote. The railway company has announced that it is willing to turn all right of way, bridges, and grade over to the provincial and Washington state governments for highway purposes.

Sandon — The output of the Silversmith mill in January amounted to 350 tons, or a total of ten cars, which were shipped to the Bunker Hill smelter, at Kellogg, Idaho. Concentrates run 67 per cent lead and 106 oz. silver. The February output will, it is estimated, total about 400 tons of concentrates and crude ore.

Three Forks—It is expected that a tramway will be put in by McAllister Mines, Ltd., from the north fork of Carpenter Creek to the company property this season.

Ainsworth — Advices from Spokane are to the effect that the Lakeshore Mining Co., owning property adjoining the Florence mine, has completed arrangements in the East for financing, and that a resumption of extensive development operations may be expected in the near future.

Poplar—A Ross gold mill and crusher have been installed at the Bullock Gold Mines property.

Trout Lake — Plans are being made for a resumption of operations on Silver Crown Mining Co.'s property near here.

Kaslo — The first shipment made by the new lessees of Utica mine ran 157.7 oz. silver, 14.6 per cent lead, and 24.6 per cent zinc.

Tax on Asbestos Reduced

The asbestos companies of Quebec province have been urging the remission of the 5 per cent royalty on asbestos on the ground that the industry is now much depressed. On Feb. 7, the Hon. J. E. Perrault, Minister of Mines, made the announcement that the government had reduced the tax on asbestos mined for export from 5 to 3 per cent for a term of four months, and to 2 per cent on asbestos manufactured within the province.

CALIFORNIA

The Engels Controversy—Power Rates Being Investigated—Water Abundant for Next Season

San Francisco Correspondence

San Francisco—Henry Engels, president of the Engels Copper Mining Co., in an endeavor to influence proxies, has issued various circular letters in which it is alleged that the management of E. E. Paxton was responsible for a cave-in of the upper workings of the Engels mine and that the present policy of marketing copper concentrates at Garfield, Utah, could be improved. Various criticisms of existing methods are also made. During the slump in the copper market, the Engels property was operated at a nominal loss and is now in excellent condition, both in development of ore reserves and in amount of broken ore and stopes ready to produce. From a diffused policy, there has been a definite compacting of facilities, a successful campaign to increase ore reserves, and a broad policy of exploitation that has placed the property in excellent condition.

The recent storms have materially added to the snowfall in California, and on Feb. 10 there was 122 in. of snow at Summit. This indicates an abundance of water for the ensuing season.

The California Metal and Mineral Producers' Association is making an investigation of the power rates in force in California in relation to the mines and dredges served by hydro-electric companies. H. G. Butler has been retained by the association to represent the interests of those engaged in the mining industry in the general rate cases now pending before the state Railroad Commission. The hearing has for its purpose the fixing of just and reasonable rates for electric service.

According to local reports, the Tonopah Mining Co. will take over the Alabama group of mines, on the Mother Lode west of Jamestown, in Tuolumne County, for exploration purposes. The Nevada Wonder, another Nevada mining company, is reported to hold an option on the Chileno, on Jackass Hill, in the Tuttletown district. The Belmont Mining Co. has operated for some time the Shawmut mine, near Chinese Camp. The entry of three successful mining companies into the Mother Lode region is significant.

Plymouth—Raymond Rodriguez was killed recently in a shaft accident at the Plymouth Consolidated. Henry Lee, a skip tender at the Plymouth, was seriously injured by a falling rock.

Angels Camp—Local reports indicate that an important strike has been made at the Victor gravel mine. The gravel is cemented, and milling will be necessary. Preparations are being made to install the necessary equipment.

Sutter Creek—Reports from the Central Eureka mine by A. S. Howe are to the effect that most of the steel for the new headframe has been received and the heavy work of erecting the hoisting equipment has been completed.

NEVADA

Tonopah Extension Recovers Anchor Vein—Ben Hur Leases Divide Junior

From Our Special Correspondent

Tonopah—Tonopah Extension reports the recovery of the Anchor vein on the 1880 level from the Victor shaft. The vein was cut off going west by a rhyolite dike and where picked up in the crosscut is about 6 ft. wide and carries good ore. Development work on the orebody recently found on the 900 level of the Halifax mine has been temporarily checked while making an air connection with a raise from the 1,000 level.

Divide—The Ben Hur company has secured a three-year lease on the property of the Divide Junior Mining Co. and on a portion of the Verdi Divide ground, and development work will be prosecuted through the Keystone shaft by agreement with this company. The shaft is now 435 ft. deep and will be sunk to the 500 level. Work will also be done from the 200 level. The 1,300 station of the Tonopah Divide mine is practically completed, and shaft sinking will soon be resumed. For the week ending Feb. 8 development totaled 97 ft., the principal work being done on the 2d and 10th levels.

Goldfield—The shaft of the Goldfield Deep Mines Co. is down 1,135 ft. No change has been anounced in the original plan to sink to the 2,400 level before any lateral development work is done.

Rochester—The January production of the Rochester Silver Corporation was below normal, the gross production being $43,483 from 3,972 tons of ore. The reduced output was due in part to adverse weather conditions. A recent discovery in an east crosscut on the 900 level may prove of importance. The vein met, which is in virgin territory, is said to be 5 ft. wide and to assay $12 per ton.

Virginia City—Construction work on the plant of the United Comstock Mines Co. is making satisfactory progress. In the main drainage tunnel there is still about 400 ft. to drive between the Knickerbocker and Belcher shafts. The ground is heavy and wet and progress is slow. Lateral tunnels and raises for mining purposes are being driven and all preparations made for mining by the caving system. The orebody on the 200 level of the Imperial is said to be over 200 ft. wide. At the Middlemines all preparatory work has been completed and drifting started from the Hale and Norcross tunnel.

Pioche—The reduced freight rates became effective on Feb. 7, and are expected to increase materially the volume of ore shipped from the district. At present the Pioche district is the only shipping point granted more favorable freight rates as a result of the conference held at Carson City last November. During the week ended Feb. 10, the Bristol Silver Mines Co. shipped 75 tons and the Black Metals mine, at Jackrabbit, 150 tons.

COLORADO

Randolph Company, at Georgetown, To Build 250-Ton Mill

Idaho Springs—The Silver Cycle Mining Co. is advancing the Wyoming Valley tunnel under contract, to cut the veins of the Gold Medal group. The installation of a new compressor plant is under consideration.

The Brazil property has been sold to B. J. Jeffry and associates, of Long Beach, Cal. The main adit level, which has been advanced about 800 ft., will be continued, and other development work will be undertaken during the month of April.

The Gem Mines Co. has completed a raise from its 1,600 level to the upper workings of the Silver Age and Freighter's Friend mines, and mining operations in this territory will be resumed in the near future.

Georgetown—The Randolph Mining Co. has arranged to erect a 250-ton mill, to be constructed of steel and concrete. The equipment will be supplied by the Denver Engineering Works Co.

Telluride—Shipments of concentrates during January were as follows: From Smuggler-Union, 85 cars to Durango, and 3 cars to Leadville; Tomboy, 55 cars; total 143 cars.

UTAH

Weekly Shipments From Park City Increase; Those From Eureka Drop

Park City—Ore shipments for the week ended Feb. 10 amounted to 2,354 tons, compared with 2,158 tons the week before. The shippers were: Judge allied companies, 1,328 tons; Silver King Coalition, 602; and Ontario, 324 tons.

Eureka—Shipments for the week ended Feb. 10 amounted to 136 cars, compared with 156 cars the week preceding. The shippers were: Tintic Standard, 46 cars; Chief Consolidated, 41; Grand Central, 17; Eagle and Blue Bell, 9; Victoria, 6; Iron Blossom, 7; Centennial Eureka, 3; Alaska, 2; Swanson, 2; Gemini, 1; Bullion-Beck, 1; and Colorado, 1.

The annual report of the Chief Consolidated for the year 1921 showed that the average value of the ores mined was $41.89 gross and the average net value $23.24. The average ore carried 0.0467 oz. gold, 34.97 oz. silver, 16.47 per cent lead; and 1.32 per cent copper. The total tonnage produced was approximately 94,000, or 10,837 tons more than the largest previous production. Development totaling 7.8 miles was done. During the year the company obtained an option on the Grand Central mine, at Mammoth, and exercised this option on Jan. 7 of this year. It also acquired control of the Apex Standard Mining Co., Eureka Lilly, and East Tintic Consolidated near the Tintic Standard, in the eastern part of the camp. Net profits for the year were $336,998.

WASHINGTON

Iron Creek Mine Now Producing—Pyrargyrite Mill To Be Started

From Our Special Correspondent

Keller—The Iron Creek Mining Co. is now on a producing basis. It is mining ore averaging 10 to 20 oz. silver, which goes to a twenty-ton stamp mill equipped with tables and cyanide tanks. A recovery of 80 per cent is reported. Of this 15 to 20 per cent is made on the tables and the remainder by cyanidation. The ore occurs as replacements in limestone and is badly oxidized. J. E. Angle is manager.

Nighthawk—The Pyrargyrite Mining & Milling Co. expects to resume operation soon at its seventy-five ton concentrator. Development work has been under way at the mine, and a carload of crude ore recently shipped to the Bunker Hill smelter yielded 100 oz. of silver to the ton.

Tacoma—The Tacoma smelter is receiving an increasing tonnage of ore from the north, now that the tramway connecting the Premier mine, in the Portland Canal district, with Stewart, B. C., is in operation.

Oroville—A shipment of crude ore from the Ruby mine to the Bunker Hill smelter, made this winter, returned over 100 oz. silver to the ton. The mill on this property is not now in operation, but it is expected that milling will be resumed this spring.

OREGON

Blue Mountain Company Sells North Pole Property

Baker—The Eastern Oregon Mining Co. has sold its North Pole property to the Blue Mountain Mining Co., and it is officially announced by Dr. Sowder, manager of the last-named company, that his company has taken possession and will operate the North Pole in conjunction with the E. & E. mine. The North Pole is on Cracker Creek, near Bourne, and about eight miles from Sumpter. Alexander Baring, of London, was the principal owner.

Homestead—It is reported the Iron Dike mine, which produced heavily for a number of years, and which has large reserves of milling ore, will resume operations this year.

SOUTH DAKOTA

Work Resumed at Anaconda Gold Mining Co.'s Prospect

Deadwood—Work has been resumed at the property of the Anaconda Gold Mining Co. near Roubaix. The shaft, which was started a few years ago and which had reached a depth on a trifle over 100 ft., is being continued, and it is planned to sink to 500 ft. When this depth is reached connections will be made with the Shaft No. 1. Buildings have been erected for the accommodation of employees, and the work will be continued until the lower depth is reached. (This property is not to be confused with the important Anaconda Copper Mining Co.)

ARIZONA

Calumet & Arizona Reported Entering Jerome District on Larger Scale—U. V. Extension Starts Operations

BY JAMES H. MCCLINTOCK

Jerome — Rumors are afloat to the effect that the Calumet & Arizona is entering the local field to a greater extent and is seeking to add the Calumet & Jerome and the Shea properties to the Verde Central and the Gadsden, both of which it now controls. It is pointed out that the Calumet & Jerome is so situated as to give Verde Central an outlet at depth. Verde Central is installing a new surface plant. Pending installation, a winze hoist is being used on the 600 level, so that sinking of the main shaft will not be delayed. Crosscutting on the 600 is to be started as soon as a new pumping plant can be put in operation.

It is also rumored that in Jerome Verde ground an important orebody has been cut by diamond drilling and that drifting will be started to it soon. This development is being prosecuted at depth in United Verde Extension, which is now in control of Jerome Verde holdings.

United Verde Extension has started one reverberatory at Clemenceau after heating for a week. About 30,000 tons of ore and 10,000 tons of flue dust and other waste are on hand for treatment, and it is expected that there will be no material increase of mining operations before April 1. The company's stock of blister in the smelter yard has been reduced to about 175,000 lb.

United Verde has been churn drilling six holes for blasting operations ahead of the steam shovels that will open up the old upper levels of the mine. The old office building, outside the former smelter site, has been demolished, as the ground it stood upon will be removed by the shovels.

Tucson—In the Superior Court, default judgment for $44,572 has been given J. H. Huntsman in his suit against the Dos Cabezas Gold Ridge Mining Corporation. In evidence were six promissory notes, signed for the corporation by J. H. Huntsman, as president, and W. A. Julian, as secretary.

In the Federal Court, on demurrer, a $20,000 damage suit against the New Cornelia company has been dismissed. The action was based on the death of José María Ochoa, in November, 1918, due to injuries from a powder explosion on the ground of the defendant company at Ajo.

TEXAS

Shipments of Sulphur Heavy

Sulphur exports from Texas City during January were 63,774 tons, according to the Texas City Terminal Railway Co. This includes shipments to Australia, British Columbia, Germany, North Atlantic ports, Pacific ports, Spain, and the United Kingdom. In addition, a large tonnage was also exported from Galveston.

JOPLIN-MIAMI DISTRICT

Missouri-Kansas-Oklahoma

Applications Made for Leases on Indian Lands—Missouri Section More Active

BY P. R. COLDREN

Joplin—Much interest is being manifested in this field by the applications for leases that have been filed with the Indian agency at Miami and which now must go to the Department of the Interior at Washington. A number of such leases have been applied for, these in most instances being applications for renewals of leases that applicants have had for some years.

George W. Beck, Jr., S. C. Fullerton, ad W. W. Dobson have applied for a lease on the Mary Whitebird tract of 236 acres, offering $16,000 bonus. They also have applied for the Harry Crawfish 160-acre tract, offering $10,000 bonus. In each proposition 25 per cent of the amount offered accompanies the application.

George W. Beck, Jr., has applied for a lease on the Joseph Whitebird tract of 200 acres and the Eudora Whitebird tract of 160 acres, offering $14,000 and $10,000 bonus, respectively.

J. W. Roberts, Homer Seals, and W. H. Walker have applied for a lease on twenty acres of land on the Federal Lead & Zinc Co.'s tract, and this same copartnership is planning to take over the Big Chief mine, which includes a forty-acre tract just north of the town of Picher.

Mining activity on the Missouri side of the field has been considerably increased in the recent weeks, notably by the starting up of the Connecticut Zinc Co.'s Circle mine, at Oronogo, with the intention of making a big tonnage. In addition to this, the Center Creek properties, at Webb City, are producing in a small way, and the Barnsdall company, at Waco, continues to be a heavy producer. During 1921 this company, with its three mines at Waco, was the heaviest producer in the field. Two of the mines are on the Kansas side of the line and the other mine, though only a few hundred yards distant, is on the Missouri side.

Records of operations show that more mines are now producing in the field than at any time in the last ten months. On June 10, 1921, only 41 mills were operating. By June 14 there were 50, but the number fell back to 39 by June 23, and on June 25 there were only 37 in operation. This was the low point. By Sept. 3 the number has increased to 45, and by Nov. 16 to 53. On Dec. 20 it was 66, on Jan. 11 this year 73, and on Feb. 11, 75.

The increase in activity does not imply a corresponding increase in production, however, as some of the larger mines have started cutting some of their thinner dirt and are not making so much ore. At one mine the dirt a month ago showed 50 per cent lead ore, but it is now showing only 4 per cent lead, and it is possible that it may be closed down.

MICHIGAN

The Copper Country

Copper Range Output Near Normal—Quincy on 75 Per Cent Basis

BY M. W. YOUNGS

Houghton—The coming of spring will witness the usual exodus of many underground workers to the farms. They may be largely replaced by miners from other districts or former residents who will return with the general resumption of mining in the district on April 1, but the labor turnover will be considerable, and all producing properties will do well to maintain an even force.

Copper Range Consolidated is now close to normal in refined-copper production. Present output is at the rate of 36,000,000 lb. per year, which is not far short of the average yearly production in the years prior to the war. Forty million pounds may be fairly taken as the normal output, refined. Production in 1915 and 1916 was unusually high, owing to the demand for copper in those years for war purposes. The output in each year was approximately 53,000,000 lb., but this was capacity production and not representative of output in years of normal market conditions.

Quincy, which normally produces about 20,000,000 lb. per year, is on a 75 per cent basis, and probably will not increase this rate of output for some time. This company, however, is in a position to bring about a sharp reduction in costs when there is a return to normal production, which course will be governed by improvement in the demand for copper. Notable improvements have been made at mine, mills, and smelter. The powerful new hoist installed a year ago at No. 2 shaft has not been pressed to capacity because of curtailed production, and as a result has not yet demonstrated its actual worth. This also applies to the new furnace at the smelter.

Mohawk and Wolverine are practically at capacity production. Mohawk is shipping about 2,300 tons of rock daily and Wolverine is averaging 900. The average yield is close to 23 lb. to the ton. An extensive program of opening work is under way in all shafts. Pillar mining and stope extensions in Wolverine are yielding rock running approximately 15 lb. to the ton in metal content.

The annual meeting of Arcadian Consolidated was held at Houghton on Feb. 14. One change was made in the board of directors, B. F. Bartholomew succeeding S. T. Everett, deceased. Both drifts, north and south, on the 1,100 level, recently reached, are in good mineralized ground. The south drift from the 942 level also continues in good copper rock.

The recent reduction of freight rates on refined copper to New York, amounting to 33⅓ per cent, effects the saving of one-fifth of a cent a pound. The reduction in rates was made effective Feb. 13.

THE MARKET REPORT

Daily Prices of Metals

Feb.	Copper, N. Y., net refinery* Electrolytic	Tin 99 Per Cent	Tin Straits	Lead N. Y.	Lead St. L.	Zinc St. L.
16	12.75@12.875	29.50	30.50	4.70	4.40	4.475@4.50
17	12.75	29.375	30.375	4.70	4.40	4.475@4.50
18	12.75	29.375	30.375	4.70	4.40	4.475@4.50
20	12.625@12.75	28.625	29.625	4.70	4.40	4.475@4.50
21	12.625	28.25	29.25	4.70	4.40	4.475@4.50
22	.....	.....	.....	....	....	.....

*These prices correspond to the following quotations for copper delivered: Feb. 16th, 13@13.125c.; 17th and 18th, 13c.; 20th, 12.875@13c.; and 21st, 12.875c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York, cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin is quoted on the basis of spot American tin, 99 per cent grade, and spot Straits tin.

London

Feb.	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic	Tin Spot	Tin 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
16	60½	61½	66	149	151	20½	20½	24	24⅝
17	60	61	66	148¼	150⅛	20⅛	20⅜	24	24⅛
18	...	...	...	.....	.....	..	...	...	..
20	58	59	64½	144	146	19⅞	19⅞	24	24½
21	58	59	63½	140	141⅞	19½	19½	24	24⅜
22	57½	58½	63½	140⅛	142⅛	19⅝	19⅝	24	24⅜

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London	Feb.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London
16	434½	99⅝	65⅜	33⅞	20	438½	99⅝	64⅞	33⅜
17	434½	99⅝	65½	34⅛	21	439	99⅝	65⅛	33⅝
18	436½	99⅝	64⅜	33¼	22	....	...	...	33⅛

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Metal Markets

New York, Feb. 21, 1922

The inactivity in the local metal market has continued during the last week, although sales of lead have been somewhat larger than usual. Prices of copper and tin are lower, but zinc and lead have held steady. Producers are generally inclined to be optimistic and feel that the spring demand cannot be postponed much further.

Copper

Those who are interested in copper mining are wondering how much farther the present decline is going to run. Many thought that increased buying at the 13c. level would arrest the movement at that point, but they have been disappointed. With present conditions—that is, several producers attempting to market current production regardless of prices—the only thing that will make conditions better is a resumption of buying. It is generally felt that the spring demand for metal for second-quarter use should manifest itself certainly by the first of March, as there has been little buying of copper since December.

Sales for the last week have been of exceedingly small proportions. Consumers showed no inclination to avail themselves of copper in any quantity at the 13c. delivered level, which was generally quoted on Friday and Saturday of last week. It was therefore necessary to shade this price, and copper could be obtained from several sources today at 12.875c. delivered, with a possibility of shading even this price for attractive orders where the delivery charge was not high. A feature of the market during the last few days has been the induction of the Anaconda interests into the buying field. This, of course, results from the fact that the American Brass Company requires more copper than Anaconda produces.

Export business has been small, although a moderate amount of inquiry from the Far East has been encouraging.

Copper for forward delivery can be obtained at approximately the same prices as for prompt and near by.

Lead

The official contract price of the American Smelting & Refining Co. remains at 4.70c. Lead can also be obtained from several other interests at this figure for New York delivery. Lead has been sold in considerably larger tonnage during the last week than for some time, although not all producers have shared in the business. Consumers seem to be enjoying a satisfactory demand for their products. Corroders evidently expect an excellent demand for paint during the spring and summer, judging by the amount of lead which they are taking. The battery manufacturers are also taking a great deal more lead than at this time last year. In fact, demand for lead from battery makers promises to be larger in the current quarter than for any quarter last year. The lead-covered cable business is also fair, the telephone companies taking increased amounts. There is also a fair demand from cartridge makers. Just at present, production and consumption seem to be almost evenly balanced. However, during the last week a new factor has projected itself into the situation. With the continued decline in London, which has now carried the price well below £20, the importation into the United States of Mexican lead becomes a factor which must be considered. The advantage of selling foreign lead in this country is not yet marked, but should the London price decline further, all of the Mexican lead at least would be marketed here. Should the demand continue to improve, this lead could easily be taken care of, and no price decline would be likely to ensue. It is probable that this condition will obtain.

Most of the sales during the last week have taken place in the New York market, and there has been a disposition to shade the usual premium for corroding grades. The St. Louis market is quiet, with most producers quoting

4.40c. There seems no disposition to unload lead on the Middle Western market in excess of the requirements.

Zinc

Zinc has been exceedingly quiet, with many producers refraining from quoting at the present price. The general quotation is 4.50c., but 4.475c. has been done on a limited number of sales. The market seems steady at current levels.

Tin

The London price of tin is the lowest since October, 1914, but when judged by the gold equivalent the situation is not quite so bad as that would indicate. The local tin market has also declined, but the higher sterling rates have helped the situation somewhat. Buying has been fair in volume, with a somewhat unusual activity among both consumers and dealers today, which forced the price up about ½c. from the morning quotations.

Tin for May delivery was quoted as follows:

Feb. 16th, 30.25c; 17th, 30c.; 18th, 30c.; 20th, 29.25c.; 21st, 29c.

Arrivals of tin, in long tons: Feb. 14th, Hongkong, 5; 15th, Straits, 10; China, 10; 16th, London, 100.

Gold

Gold in London: Feb. 16th, 95s. 7d.; 17th, 95s. 7d.; 20th, 95s. 4d.; 21st, 94s. 9d.; 22d, 93s. 10d.

Foreign Exchange

European exchanges have been generally strong and higher. On Tuesday, Feb. 21, francs were 9.125c.; lire, 5.02c.; and marks, 0.455c. New York funds in Montreal, 2¾ per cent premium.

Silver

The market has continued quiet, with all the support coming from Indian bazaar buying. China's position is still that of a seller, and America has also sold in London. San Francisco reports no business, and the volume in New York is small. The market closes uncertain.

Mexican Dollars—Feb. 16th, 49¾, 17th, 49¾; 18th, 48¾, 20th, 49¾, 21st, 50.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—20c. per lb. for 99 per cent grade; 19c. for 98@99 per cent; 18c. for 94@98 per cent. Outside market nominal at 17@18c. for 98@99 per cent virgin grades.

Antimony — Chinese and Japanese brands, 4.40c.; market dull. W.C.C. brand, 5¼@5½c. per lb. Cookson's "C" grade, spot, 9c. Chinese needle antimony, lump, nominal at 4c. per lb. Standard powdered needle antimony (200 mesh), nominal at 5.25c. per lb.

White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, wholesale lots, 6½@7c.

Arsenic—7½c. per lb. Strong.

Bismuth—$2@$2.10 per lb.

Cadmium—$1@$1.10 per lb., in 1,000-lb. lots. Smaller quantities, $1.10@$1.25 per lb.

Iridium—Nominal, $170@$190 per oz.

Nickel—Standard market, ingot and shot, 41c.; electrolytic, 44c. Small tonnages, spot, nominal at 32c.

Palladium—Nominal, $55@$60.

Platinum—$85@$90 per oz.

Quicksilver—$48 per 75-lb. flask. San Francisco wires $47.30. Firm.

The prices of **Cobalt, Molybdenum, Monel Metal, Osmium, Rhodium, Selenium, Thallium and Tungsten** are unchanged from the prices in the issue of Feb. 4.

Metallic Ores

Bauxite — American, crushed and dried, $6@$8 per gross ton; pulverized and dried, $12@$14 per gross ton; calcined, $20@$22 per gross ton, all f.o.b. shipping points. Foreign bauxite offered at $6@$8 per metric ton, c.i.f. Atlantic ports, depending upon grade.

The prices of **Chrome, Manganese, Tungsten, Molybdenum, Tantalum, Uranium, Vanadium,** and **Iron Ore, Zircon** and **Zirkite** are unchanged from the prices in the issue of Feb. 4.

Zinc and Lead Ore Markets

Joplin, Mo., Feb. 18—Zinc blende, per ton, high, $30.45; basis 60 per cent zinc, premium, $27@$26; Prime Western, $25@$24; fines and slimes, $23; average settling basis, all blende ores, $27.16.

Lead, high, $64.55; basis 80 per cent lead, $60; average settling price, all grades, $62.49 per ton.

Shipments for the week: Blende, 5,723; lead, 1,834 tons. Value, all ores the week, $270,070.

All efforts on the part of buyers to break the holding price for blende continue to fail, but week after week purchases grow less, with only 5,880 tons sold this week.

Federal Lead continues to take the bulk of the lead output by maintaining the basis at $60, at which prices others are not caring to fill large orders.

Platteville, Wis., Feb. 18—Blende, no sales. Lead ore, basis 80 per cent lead, $60 per ton. Shipments for the week: Blende, none; lead ore, 32 tons. Shipments for the year: Blende, 1,703, lead ore, 489 tons. Shipped during the week to separating plants, 487 tons blende.

Non-Metallic Minerals

There are no price changes from those indicated in the market report of the issue of Feb. 4 covering **Asbestos, Barytes, Borax, Chalk, China Clay, Emery, Feldspar, Fluorspar, Fuller's Earth, Graphite, Gypsum, Limestone, Magnesite, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur** and **Talc.**

Mineral Products

The prices of **Copper Sulphate, Potassium Sulphate, Sodium Nitrate** and **Sodium Sulphate** are unchanged from the issue of Feb. 4.

Ferro-Alloys

Ferromanganese—Domestic, 78 to 82 per cent, $59@$60, f.o.b. furnace; English and German, $62.50, c.i.f. Atlantic seaport. Spiegeleisen, 16 to 19 per cent, $30 per gross ton, f.o.b. furnace; 19 to 21 per cent, $35, stronger.

Ferrovanadium—$4 per lb. of V contained, according to analyses and quantity.

The prices of **Ferrotitanium, Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrosilicon, Ferrotungsten** and **Ferro-uranium** are unchanged from the issue of Feb. 4.

Metal Products

Nickel Silver—26.75c. per lb. for 18 per cent quality Grade "A" sheets.

Yellow Metal — Dimension sheets, 17.25c.; sheathing, 16.75c.; rolls, ⅜ to 3 in., 14.75c.

Copper Sheets—Current New York list price, 20.25c. per lb.; wire, 14.50@14.75c.

The prices of **Lead Sheets** and **Zinc Sheets** are unchanged from the issue of Feb. 4.

Refractories

The prices of **Bauxite Brick, Chrome Brick, Chrome Cement, Firebrick, Magnesite Brick,** and **Silica Brick** are unchanged from the issue of Feb. 4.

The Iron Trade

Pittsburgh, Feb. 21, 1922

Demand for steel has continued to broaden in a satisfactory way, viewing the tonnage in the aggregate, as ingot production is now at between 26,000,000 and 28,000,000 tons a year, the rate at the end of December having been under 18,000,000 tons. Last autumn's rate, the best since early in the year, was 23,000,000 tons. Production in 1921 aggregated about 19,500,000 tons, so that the industry is now doing about 40 per cent better in tonnage.

Steel prices are uneven, with the exception of sheet prices, and further assurance of the steadiness of this market is the opening of order books yesterday by the American Sheet & Tin Plate Co. for second quarter at unchanged prices, 2.25c. for blue annealed, 3c. for black, and 4c. for galvanized. Bars, shapes, and plates are now more commonly done at 1.40c. than at 1.50c., and nails go more at $2.40 than at $2.50

Pig Iron—Furnaces are now firm on basis at $18, Valley, and indeed are nominally quoting $18.25. The $18 price was paid by the Allegheny Steel Co. on 1,000 tons. The Standard Sanitary Manufacturing Co. has bought upward of 1,000 tons of foundry iron for each of its three plants, getting the southern iron, for Louisville, at $15, Birmingham, a new low price, and paying $18.75 to $19, Valley basis, for the northern for the other two plants. Bessemer remains at $19.50, Valley.

Coke

Connellsville — Furnace, $2.85@$3; foundry, $3.75@$4.25.

The Porphyry Coppers' Past and Future

BY F. E. CALKINS
Written for *Engineering and Mining Journal*

TECHNICAL and financial results of operations of the so-called porphyry copper mines of the United States from the beginning of operations to Dec. 31, 1920, are summarized in the accompanying table. Following are the names of companies covered by this record, the situation of the mines, and general method of mining employed:

Utah Copper Co., Bingham, Utah; steam shovel. Nevada Consolidated Copper Co., Ely, Nev.; steam shovel and underground. Chino Copper Co., Santa Rita, N. M.; steam shovel. Ray Consolidated Copper Co., Ray, Ariz.; underground. Miami Copper Co., Miami, Ariz.; underground. Inspiration Consolidated Copper Co., Miami Ariz.; underground. New Cornelia Copper Co., Ajo, Ariz.; steam shovel.

This group of mines has become an increasingly important factor in the world's copper production, and, before the general shut-down early in 1921, was contributing about one-third of the annual production of the United States and 20 per cent of the world production. In the future, including the operation by the Detroit branch of Phelps Dodge Corporation and the Arizona Copper mine at Morenci, which are now really porphyry mines; the recently developed Sacramento Hill at Bisbee, Ariz.; the further exploitation of the Braden, Chile, and Andes mines, in Chile, and the probable discovery of new deposits, this class of large, low-grade copper deposits will eventually occupy the dominant position in the copper production of the world.

The ore from the first six mines mentioned is concentrated by combined gravity and flotation methods, the concentrate smelted, and resulting blister copper electrolytically refined. Ajo has thus far operated only on oxidized ore, which is treated by leaching and electrolytic precipitation, producing electrolytic copper direct and some cement copper, which is smelted. In the following discussion only the first six mines are referred to unless Ajo is specifically mentioned.

Under "Ore Reserves," the figure for Inspiration is obtained by subtracting tonnage mined from originally estimated tonnage, as no figure has been published recently. It is probable that none of the mines has completely exhausted its possibilities for developing new ore.

The next column gives the estimated percentage of copper in ore reserves at the time of beginning operations, since which time much additional ore has been developed and lower-grade material has been included in the calculations. The discrepancy between these figures and those representing percentage of copper in ore milled has been due to the combined effect of three factors: unavoidable sampling error, dilution by waste rock in mining, and deliberate mining of lower-grade ore that was not included in the original estimates, but which it was later found could be mined at a profit.

Averaging results at all the mines, it is seen that the mill recovery has been 69.1 per cent and the mill and smelter recovery—that is, the net recovery in fine copper—has been 66.8 per cent, or almost exactly two-thirds, the other third being represented by mill and smelter losses. The average recoveries for the future will greatly exceed these figures. A considerable part of the total tonnage was treated before the advent of the flotation method, with its higher recoveries. Furthermore, although the ores thus far mined have been classed as sulphide ores, they have all contained a considerable proportion of copper in the form of oxidized copper minerals, of which it has been possible to recover only a small percentage, perhaps 30 per cent, by either gravity or flotation methods. Although some of the mills have been able to save 90 per cent or more of the sulphide copper, the low recovery of the oxide copper has reduced the total recovery to a much lower figure.

Recoveries are even now considerably in excess of past averages. For the year 1920 the mill recoveries at Utah, Ray, and Miami were all over 81 per cent, the recovery at Miami being 82.5 per cent, and the average for all six mines was 76.7 per cent, as compared with the past average of 69.1 per cent. Some of the mines will probably eventually attain a net recovery in fine copper of over 85 per cent and the future average for all the mines over the remainder of their life may exceed 80 per cent, as compared with the past average of 66.8 per cent.

The figures under "Total Profits" are the actual profits, that either went into dividends or to building up working capital, and are obtained by adding total dividends to net quick assets as of Dec. 31, 1920. Subtracting the resulting profit per pound of fine copper from the price received gives the cost per pound. This cost is credited with gold and silver proceeds and miscellaneous income and includes all construction and extraordinary development expense that was paid out of earnings. All the mines but Inspiration have increased their capacity from earnings, that company having built its plant to the desired capacity from original capital. Construction expense that increases capacity is considered as an addition to capital upon which a profit must be earned, but from the shareholder's viewpoint it is a cost, as he will never get his hands on any money that has been spent for plant that will be junk when the mine is exhausted.

It seems likely that, due to a change in general industrial and financial conditions, certain factors in cost will be higher than the pre-war average for some time to come, but, because of the interrelation of cost and price, any change in average cost should be reflected in a similar change in average price. If the average cost over a future long period is going to exceed the pre-war average, it is reasonably certain that the average price will exceed the pre-war average of 15c. in similar ratio, with little change in the ratio of profit to price.

Perhaps the most important figure and the only one that can be directly applied in estimating future results is "Ratio of Profit to Price," that is, the ratio of profit per pound to price received per pound. J. R. Finlay, in his "Cost of Mining," has pointed out an interrelation of cost and price, and hence of profit and price, that varies from year to year but tends to average nearly constant over long periods, and the following paragraphs attempt to show the reason.

A study of price and cost curves for individual mines over a fairly long period shows that variations in price are followed by corresponding similar variations in cost, but although price responds rapidly to variations in demand, the cost moves slowly and ponderously like a heavy body, slow to start and hard to stop, and its movements lag behind those of price, so that there are alternating periods of divergence and convergence of the curves, with consequent alternating periods of high and low ratio of profit to price, but the average ratios over equal fairly long periods tend to be about the same. In unprofitable periods the dropping price curve approaches the rising cost curve. In 1920 the curves actually met, with extinction of profit. We are now in a period of rising price and decreasing cost.

A fairly constant element in cost is inexorably imposed by Nature—namely, the quantity of capital, labor, and material necessary to discover and produce a pound of copper. A certain natural limitation is placed upon cost, and hence on price, independently of variations due to changes in the ratio of supply to demand. The reason that the price of copper has consistently averaged over three times that of lead is because it takes over three times as much capital, labor, and material to discover and produce a pound of copper as it does to win a pound of lead. This quantity is different for different mines and different classes of mines, but, for the industry as a whole and for individual mines, it tends to a fairly constant average over long periods, and will gradually increase with the decline of the industry and with the approaching mine exhaustion.

The tendency is continually toward higher recovery, increased tonnage capacity, and greater general efficiency, the immediate effect of which is to lower the cost per pound,

but the average combined effect over a long period is to lower the grade of ore mined and the yield in pounds of fine copper per ton; increase the total available tonnage, copper, and profits; and increase the average annual profit per share by an amount at least equal to a fair return on the additional capital per share that was invested to get the increased recovery and capacity without much change in the average cost per pound. Thus the present value per share is increased by both the additional annual profit per share and the increase in total available profits. Always, of course, the objective is not cost per pound, nor only annual profit per share, but the creation of the greatest possible present value with the least capital expenditure that natural limitations will permit, and these natural limitations prescribe the minimum combined quantity of capital, labor, and material that is necessary to discover and produce a pound of copper.

One influence that tends to maintain a constant relation between average price and average cost for the industry as a whole is the necessity that average price must be composed of average cost plus an average profit on invested capital commensurate with the risk involved, for the industry to exist and grow. When profit declines, new capital investment is halted and the ratio of production to demand declines until price and profit begin to rise again, so that over long periods there tends to be a fairly constant relation between cost, profit, and price.

It seems likely that for some mines the future average grade of mill feed may be less than 1 per cent copper and the yield in fine copper as low as 15 or 16 lb. per ton and still return the present invested capital, with a good rate of interest. This means that, under favorable conditions and with sufficiently large tonnage, a body of copper-bearing rock whose sampling by churn drills indicates a copper content of about 1¼ per cent, and hence about 1 per cent mill feed, can now be classed as ore and be made the basis of a profitable operation, and it is safe to say that the time will come, and may not be far distant, when the same remarks will apply to material whose indicated content is only 1 per cent.

As long as grade of ore is controllable, it will be maintained at a point that will give a yield in fine copper that will create the greatest present value. In the last years of life, grade will be the controlling factor.

From the foregoing considerations it is reasonable to conclude that, for most of the mines that have operated over the longer periods, the past ratios can be safely applied over a future long period and will be exceeded at some of the mines, owing principally to the effect of increased capacity; and that in estimates covering a future long period, say fifteen years, a ratio of 37 per cent can be safely used as the average for the group. This means that for every dollar received from sale of copper, 37c. should be applicable to dividends or working capital, and, after working capital has been replenished, to dividends alone.

Computing present values is a dangerous pastime if done without a more detailed knowledge of the entering factors than is ordinarily available. Estimates of future dividends based on this table of past results alone would be seriously in error. Following are the essential factors except interest, and most of them are difficult to estimate closely:

(1)—Future average annual tons milled.
(2)—Future average per cent coper in mill feed.
(3)—Future average mill and smelter recovery.
(4)—Future average ratio of profit to price.
(5)—Future average price.
(6)—Life of the mines.

(1) and (3)—Will be considerably higher than the past average and should result in an important increase in the future average annual profits per share for most of the mines.

(2)—Will be much lower than the past average and the future average yield, for the group will be lower.

(4)—Can be estimated closely from records, and it is safe to use the figure of 37 per cent as the average for the group over a long future period. In the last years of life this ratio will steadily decrease, as the mines will continue to operate on lower and lower grade ore as long as there is any operating profit at all, and the average ratio for the whole future life may be less than this.

Estimates of (5) will vary with the optimism of the estimator, but it is logical to assume that it will bear about the same relation to the pre-war average of 15c. that the future general price level will have to the pre-war general level, at least until that time when the shortage of copper will force an increase in both price and cost independently of general conditions.

(6)—Is difficult to estimate closely, as additional ore will probably be developed at most of the mines. It will also depend on (1), which is uncertain, but which almost certainly will be considerably higher in the future than in the past. The effect of any further increase in tonnage capacity will be to shorten the life, but its effect, and the effect of increased recovery, will also be to lengthen life by making lower-grade ore available. However, considerably longer life than is indicated by the figures on ore reserves and tonnage capacity may be expected.

It can be stated that the intrinsic value of most of these properties, computed on a conservative basis, is considerably higher than the recent market value, though the market prices closely reflect the relative values, with a few exceptions.

It is impossible to study this record of operations without being impressed by the tremendous achievement of the American engineers who extracted these profits from rock that yielded only 20 lb. of copper to the ton.

PORPHYRY COPPERS' RECORD FROM BEGINNING OF OPERATIONS TO DEC. 31, 1920

Name of Mine	Ore Reserves Dec. 31, 1920 Tons	Ore Reserves Dec. 31, 1920 Per Cent Cu	Orig. Est., Per Cent Cu	Total Ore Milled Tons	Total Ore Milled Per Cent Cu	Total Fine Cu Produced, lb.	Fine Cu In. lb. Per Ton	Mill Recov., Per Cent	Mill and Smelter Recov., Per Cent	Year of Inc.	First Full Yr. of Oper.	Yrs. of Oper.	No. of Shares Issued
Utah	364,130,000	1.35	2.00	89,340,223	1.37	1,546,153,606	17.3	66.0	63.2	1903	1908	13	1,624,470
Nevada	63,845,000	1.58	1.97	35,180,801	1.60	759,680,986	21.6	70.0	67.2	1904	1909	12	1,999,457
Chino	105,689,000	1.53	2.24	21,532,415	1.85	510,313,779	23.7	66.6	64.2	1909	1912	9	869,980
Ray	83,004,000	2.07	2.17	23,522,127	1.68	559,532,318	23.8	71.4	70.8	1907	1912	9	1,577,179
Miami	10,723,000(a) 36,000,000(a) 6,000,000(c)	2.26 1.06 2.00	2.48	14,104,887	2.12	421,806,746	29.9	74.2	70.5	1907	1912	9	747,114
Inspiration	72,000,000	1.63	1.63	24,462,809	1.36	477,439,016	19.5	74.2	72.0	1911	1916	5	1,181,967
Total	739,400,000	1.51		208,143,000	1.54	4,274,926,000	20.5	69.1	66.8				
Ajo	8,234,000(b) 42,000,000(a)	1.49 1.50	1.57 1.59	6,032,097	1.54	146,046,284	24.2	79.0		1909	1918	3	1,800,000

Name of Mine	Par Value, Share	Total Dividends	Div. Per Share	Total Profits (f)	Profit Per Ton	Profit Per Lb., Cents	Price Recd. Lb., Cents	Cost Per Lb., Cents	Cost Per Ton	Ratio Profit to Price, Per Cent	Div. Per Lb., Cents	Ratio Div. to Price, Per Cent	Average Annual Dividend, Per Share	Approximate Annual Capacity, Tons
Utah	$10	$111,509,662(d) 88,264,000(e)	$70.75	$132,617,808(d) 109,372,000(e)	$1.23	7.08	18.64	11.5	$2.00	38.0	5.70	30.6	$5.45	14,000,000
Nevada	5	46,768,616	23.40	55,471,665	1.58	7.30	17.90	10.6	2.29	40.7	6.17	34.4	1.95	5,000,000
Chino	5	29,991,709	34.52	33,952,546	1.58	6.66	19.85	13.2	3.13	33.5	5.88	29.6	3.83	3,800,000
Ray	10	25,412,620	16.32	33,578,890	1.43	6.00	19.70	13.7	3.26	30.4	4.54	23.0	1.81	3,500,000
Miami	5	22,950,660	30.75	30,200,787	2.14	7.16	20.1	13.0	3.87	35.6	5.44	27.0	3.42	2,000,000
Inspiration	20	38,678,671	33.00	47,957,201	1.95	10.00	22.0	12.0	2.34	45.4	8.10	36.8	6.60	5,000,000
Total		$252,066,276		$310,533,000	$1.49	7.3	19.3	12.0	$2.46	37.8	5.9	30.5		33,000,000
Ajo	$5	$1,350,000	$0.75											

(a) Sulphide ore. (b) Oxide ore. (c) Mixed ore. (d) Total. (e) From operations. Balance of total is from dividends on 1,000,500 shares of Nevada. (f) Total profits equal total dividends plus net quick assets as of Dec. 31, 1920.

MINING STOCKS

Week Ended February 18, 1922

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	62	61	61	Sept. '20, Q	$0.50
Alaska-Br. Col. new.	N. Y. Curb	2 1/4	2 1/8	2 1/4		
Allouez	Boston	28 1/2	27	27	Mar. '19	1.00
Anaconda	New York	49	47 1/4	48 1/4	Nov. '20, Q	1.00
Arcadian Consol.	Boston	2 1/4	2 1/4	2 1/4		
Ariz. Com'l	Boston	9	8 1/2	8 3/4	Oct. '18, Q	0.50
Big Ledge	N. Y. Curb	*25	*23	*24		
Bingham Mines	Boston	14	13 1/2	14	Sept. '19, Q	0.25
Calumet & Arizona	Boston	59 1/2	58	59	Dec. '21, Q	0.50
Calumet & Hecla	Boston	285	275	275	June '20, Q	5.00
Canada Copper	N. Y. Curb	*27	*25	*26		
Centennial	Boston	12	12	12	Dec. '18, SA	1.00
Cerro de Pasco	New York	34 3/8	33 1/4	33 1/2	Mar. '21, Q	0.50
Chile Copper	New York	17 1/4	15 7/8	16 1/8		
Chino	New York	26 1/2	26	26	Sept. '20, Q	0.37 1/2
Columbus Rexall	Salt Lake	*27	*26	*27		
Con. Arizona	N. Y. Curb	*3	*2	*2	Dec. '18, Q	0.05
Con. Copper Mines	N. Y. Curb	1 5/16	1 1/4	1 5/16		
Copper Range	Boston	43	41 1/4	41 1/4	Sept. '20, Q	0.50
Crystal Copper	Boston Curb	*59	*54	*58		
Davis-Daly	Boston	8 1/4	7 1/2	7 1/2	Mar. '20, Q	0.25
East Butte	Boston	10 3/8	10 1/2	10 3/4	Dec. '19, A	0.50
First National	Boston Curb	*70	*60	*70	Feb. '19, SA	0.15
Franklin	Boston	1 3/4	1 3/4	1 3/4		
Gadsden Copper	Boston Curb	*55	*45	*45		
Granby Consol.	New York	†29 1/2	†27	28 1/4	May '19, Q	1.25
Greene-Cananea	New York	26 3/8	25 7/8	26 7/8	Nov. '20, Q	0.50
Hancock	Boston	2 3/4	2 1/2	2 3/4		
Howe Sound	N. Y. Curb	2 1/2	2 3/8	2 3/8	Jan. '21, Q	0.05
Inspiration Consol.	New York	39	37 3/4	38 1/2	Oct. '20, Q	1.00
Iron Cap	Boston Curb	†*7 3/8	†*7	*7	Sept. '20, K	0.25
Isle Royale	Boston	23 1/4	23	23	Sept. '19, SA	0.50
Kennecott	New York	27 3/4	26 7/8	27 1/2	Dec. '20, Q	0.50
Keweenaw	Boston	†1 1/2	†1 1/2	1 1/2		
Lake Copper	Boston	2 1/8	2 1/8	2 1/4		
La Salle	Boston	2	1 7/8	2		
Magma Copper	N. Y. Curb	31 1/4	30	30 1/2	Jan. '19, Q	0.50
Majestic	Boston Curb	†*6	†*5	*3		
Mason Valley	Boston	1 7/16	1 7/16	1 7/16		
Mass Consolidated	Boston	2 1/4	2 1/4	2 1/4	Nov. '17, Q	1.00
Miami Copper	New York	26 1/2	25 3/4	26 1/8	Feb. '22 Q	0.50
Michigan	Boston	1 3/8	1 3/8	1 3/8		
Mohawk	Boston	56 1/2	55 7/8	56	Nov. '20, Q	1.00
Mother Lode Coa.	N. Y. Curb	8 1/4	7 7/8	7 7/8		
Nevada Consol.	New York	14	13 1/2	13 1/2	Sept. '20, Q	0.25
New Cornelia	Boston	18	17 1/2	17 7/8	Aug. '20, K	0.25
North Butte	Boston	12	11	11 1/2	Oct. '18, Q	0.25
North Lake	Boston			*25		
Ohio Copper	N. Y. Curb	*10	*10	*10		
Old Dominion	Boston	24 1/2	23 1/2	23 1/2	Dec. '18, Q	1.00
Osceola	Boston	33	32 1/4	32 1/2	June '20, Q	0.50
Phelps Dodge	Open Mar.	†190	†175	...	Jan. '22, Q	1.00
Quincy	Boston	43 1/2	42 1/2	43 1/2	Mar. '20, Q	1.00
Ray Consolidated	New York	14	13 3/8	13 7/8	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*3	*2	*2		
St. Mary's Min. Ld.	Boston	45 1/2	44	45 1/2	Dec. '21, K	1.00
Seneca Copper	Boston	13 3/8	12 1/2	12 3/4		
Shannon	Boston	1	1	1	Nov. '17, Q	0.25
Shattuck Arizona	New York	8	7 3/4	8	Jan. '20, Q	0.25
South Lake	Boston	†1	†*65	*65		
Superior & Boston	Boston	1 1/8	1	1		
Tenn. C. & C. cfs	New York	10 1/2	10 1/4	10 3/8	May '18, I	1.00
Tuolumne	Boston	*60	*60	*60	May '13,	0.10
United Verde Ex.	Boston Curb	29	28	28 1/2	Feb. '22, Q	0.25
Utah Consol.	Boston	2 1/4	2	2	Sept. '18,	0.25
Utah Copper	New York	63 1/4	61	61 1/2	Dec. '21, Q	0.50
Utah Metal & T.	Boston	1 1/4	1	1	Dec. '17,	0.30
Victoria	Boston	2 1/4	2	2 1/4		
Winona	Boston	*45	*45	*45		
Wolverine	Boston	11 1/2	10 1/2	11		
NICKEL-COPPER						
Internat. Nickel	New York	12 3/8	12	12 1/2	Mar. '19,	0.50
Internat. Nickel, pfd	New York	69	62	62	Nov. '21, Q	1.50
LEAD						
National Lead	New York	90 3/8	88	90 3/8	Dec. '21, Q	1.50
National Lead, pfd.	New York	†113	†111	112	Dec. '21, Q	1.75
St. Joseph Lead	New York	13 7/8	13 3/8	13 7/8	Dec. '21, Q	0.25
QUICKSILVER						
New Idria	Boston	†1 1/2	†*75	1		
ZINC						
Am. Z. L. & S.	New York	13 3/8	13 1/4	13 3/8	May '20,	1.00
Am. Z. L. & S. pfd.	New York	36 1/2	36 1/8	36 1/8	Nov. '20, Q	1.50
Butte C. & Z.	New York	5 1/2	5 3/8	5 3/8	June '18,	0.50
Butte & Superior	New York	27 1/4	25 7/8	26	Sept. '20,	1.25
Callahan Zn-Ld.	New York	5 3/8	5 1/4	5 1/4	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	137	136	136	Feb. '22, Q	2.00
Yellow Pine	Los Angeles	...	...	*50	Sept. '20, Q	0.03

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Hamilton B. Wills; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Commerce and Oil; Colorado Springs, The Financial Press, N. Y.

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	1/8	1/8	1/8		
Alaska Juneau	New York	1/8	1/8	1/8		
Carson Hill	New York	15 1/4	15	15		
Cresson Consol. G.	N. Y. Curb	2 1/16	2 1/16	2 1/8	Jan. '22, Q	$0.10
Dome Extension	Toronto	1.00	*83	1.00		
Dome Mines	New York	23 1/2	22 7/8	23 1/2	Jan. '22, Q	0.25
Florence Goldfield	N. Y. Curb	*25	*21	*25		
Golden Cycle	Colo. Springs	†*81	†*78	*51	June '21, Q	0.02
Goldfield Consol.	N. Y. Curb			*4	Dec. '19,	0.05
Hollinger Consol.	Toronto	8.54	8.50	8.53	Jan. '22,	0.05
Homestake Mining	New York	61 1/2	61	61	Jan '22, M	0.25
Kirkland Lake	Toronto	*35 1/2	*30	*33		
Lake Shore	Toronto	1.50	1.43	1.49	Nov. '21, K	0.02
McIntyre-Porcupine	Toronto	2.58	2.50	2.55	Jan. '22, K	0.05
Porcupine Crown	Toronto	*19	*17	*18 1/2	July '17,	0.03
Porcupine V. N. T.	Toronto	*25 1/2	*23	*24		
Portland	Colo. Springs	*39	*39	*39	Oct. '20, Q	0.01
Schumacher	Toronto	*36	*35	*36		
Silver Pick	N. Y. Curb			*2		
Teck Hughes	Toronto	*31	*29 1/2	*30		
Tom Reed	Los Angeles	*79	*70	*77	Dec. '19,	0.02
United Eastern	N. Y. Curb	2 1/16	1 15/16	1 15/16	Jan. '22, Q	0.15
Vindicator Consol.	Colo. Springs	*22	*22	*22	Jan. '20, Q	0.01
White Caps Mining	N. Y. Curb	*3	*3	*3		
Yukon Gold	N. Y. Curb	1 1/4	1 1/8	1 1/4	June '18,	0.02 1/2
SILVER						
Batopilas Mining	New York	1/8	1/8	1/8	Dec. '07, I	0.12 1/2
Beaver Consol.	Toronto	*24	*20 1/2	*23 1/2	May '20, K	0.03
Coniagas	Totonto	1.25	1.25	1.25	May '21, Q	0.12 1/2
Crown Reserve	Toronto	*16	*14 1/2	*15 1/2	Jan. '17,	0.05
Kerr Lake	N. Y. Curb	3 1/4	3 1/4	3 1/4	Jan. '22, Q	0.12 1/2
La Rose	Toronto	*38	*36 1/2	*37	Apr. '18,	0.02
McKinley-Dar.-Sav.	Toronto	*19 1/2	*18 1/2	*19 1/2	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	1.15	1.01	1.10	Sept. '20, Q	0.12 1/2
Nipissing	N. Y. Curb	6	5 1/2	5 7/8	Jan. '22, Q	0.15
Ontario Silver	New York	5 3/8	5 1/2	5 1/2	Jan. '19, Q	0.50
Ophir Silver	N. Y. Curb	...	...	*12	Jan. '12,	0.10
Temiskaming	Toronto	*34	*31	*32 1/2	Jan. '20, K	0.04
Trethewey	Toronto	*4 1/2	*2 1/2	*3 1/2	Jan. '19,	0.05
GOLD AND SILVER						
Boston & Montana	N. Y. Curb	*47	*42	*46		
Cash Boy	N. Y. Curb	*5	*5	*5		
Dolores Esperanza	N. Y. Curb	1 3/8	*85	85		
El Salvador	N. Y. Curb	*5	*3	*3		
Jim Butler	N. Y. Curb	...	...	*6	Aug. '18, SA	0.07
Jumbo Extension	N. Y. Curb	...	...	*4	June '16,	0.05
MacNamara M.&M.	N. Y. Curb	*8	*6	*8	May '10,	0.02 1/2
Tonopah-Belmont	N. Y. Curb	1 5/16	1 1/2	1 5/16	Jan. '22, Q	0.05
Tonopah-Divide	N. Y. Curb	*63	*60	*63		
Tonopah-Extension	N. Y. Curb	1 3/8	1 5/16	1 3/8	Jan. '22, Q	0.05
Tonopah Mining	N. Y. Curb	1 1/16	1 1/8	1 1/16	Oct. '21, SA	0.05
West End Consol.	N. Y. Curb	*76	*73	*75	Dec. '19, SA	0.05
SILVER-LEAD						
Caledonia	N. Y. Curb	*5	*5	*5	Jan. '21, M	0.01
Cardiff M. & M.	Salt Lake	1.02 1/2	1.00	1.02 1/2	Dec. '20,	0.15
Chief Consol.	Boston Curb	3 3/8	3 7/16	3 7/16	Aug. '21, Q	0.05
Consol. M. & S.	Montreal	19	18 1/2	18 1/2	Oct. '20, Q	0.62 1/2
Daly Mining	Salt Lake	†3.00	†1.25	...	July '20, Q	0.10
Daly-West	Boston	2 1/4	2 1/4	2 1/4	Dec. '20, Q	0.25
Eagle & Blue Bell	Boston Curb	2 1/4	2 1/2	2 1/2	Apr. '21, K	0.05
Electric Point	Spokane	*5	*4 1/2	*5	May '20, SA	0.03
Federal M. & S.	New York	†12	†8	...	Jan. '09,	1.50
Federal M. & S., pfd	New York	39 1/2	38	38 1/2	Dec. '21, Q	1.00
Florence Silver	Spokane	*19	*19	*19	Apr. '19,	0.01 1/2
Grand Central	Salt Lake	*42	*42	*42	Jan. '21, K	0.01
Hecla Mining	N. Y. Curb	5 3/8	5 1/4	5 3/8	Dec. '21, Q	0.17
Iron Blossom Con.	N. Y. Curb	*20	*19	*19	Dec. '21, Q	0.02 1/2
Judge M. & S.	Salt Lake	†3.25	†2.80	3.00	Sept. '20, Q	0.12 1/2
Marsh Mines	N. Y. Curb	*4	*4	*4	June '21, I	0.02
Prince Consol.	Salt Lake	*8	*6 1/2	*8	Nov. '17,	0.02 1/2
Rambler-Cariboo	Spokane	*6	*5 1/4	*6	Feb. '19,	0.01
Rex Consol.	N. Y. Curb	*8	*6	*7		
South Hecla	Salt Lake	†*60	†*35	...	Sept. '19, K	0.15
Standard Silver-Ld.	N. Y. Curb	*18	*18	*18	Oct. '17,	0.05
Stewart Mines	N. Y. Curb	*4	*3	*3	Dec. '15,	0.05
Tamarack-Custer	Spokane	2.10	1.90	2.10	Jan. '21, K	0.04
Tintic Standard	Salt Lake	2.15	2.02 1/2	2.15	Dec. '21, Q	0.05
Utah Apex	Boston	3 1/2	3	3	Nov. '20, K	0.25
Wilbert Mining	N. Y. Curb	*2	*2	*2	Nov. '17,	0.01
VANADIUM						
Vanadium Corp.	New York	35 1/8	34	34 1/4	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp	Montreal	47	46	46	Jan. '22, Q	1.50
Asbestos Corp., pfd.	Montreal	75	74	75	Jan. '22, Q	1.75
SULPHUR						
Freeport, Texas	New York	13 7/8	13 1/4	13 1/4	Nov. '19, Q	1.00
Texas Gulf	New York	44	42 1/2	44	Dec. '21, Q	1.00
MINING, SMELTING AND REFINING						
Amer. Sm. & Ref.	New York	46 1/4	45 1/2	46	Mar. '21, Q	1.00
Amer. Sm.& Ref. pf.	New York	91	90 3/8	90 3/8	Dec. '21, Q	1.75 1/2
Am. Sm. Sec. pf. A.	New York	87 1/2	87	87 1/2	Jan. '22, Q	1.50
U. S. Sm. R. & M.	New York	34 1/2	34	34	Jan. '21, Q	0.50
U.S. Sm.R.& M. pf.	New York	43 1/2	43 1/2	43 1/2	Jan. '22, Q	0.87